This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

**Usage guidelines**

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

**About Google Book Search**

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

GODFREY LOWELL CABOT
SCIENCE LIBRARY

HARVARD COLLEGE LIBRARY

GIFT OF

JOHN G. PALFREY, D.D, LL. D.

Rev D^r Palfrey

From the Author

THE

# EXCISE OFFICER'S MANUAL,

AND

# Improved Practical Gauger.

Drawn on Stone by C. Burton, 42 Carey St.

J. Bateman:

THE

# EXCISE OFFICER'S MANUAL,

AND

# Improved Practical Gauger;

BEING A COMPENDIOUS INTRODUCTION TO THE BUSINESS OF
CHARGING AND COLLECTING THE DUTIES OF EXCISE.

BY

Joseph
J. BATEMAN.

LONDON:
A. MAXWELL, 32, BELL YARD, LINCOLN'S INN,
LAW BOOKSELLER TO HER MAJESTY:
AND S. COCK, STORE OFFICE, EXCISE OFFICE, BROAD STREET:
SOLD ALSO BY J. LONG, LITTLE TOWER STREET:
AND MILLIKEN AND SON, DUBLIN.

1840.

Math 8108.40

1863. April 30.
Gift of
Hon. John G. Palfrey
(Class of 1815.)

2565 56

W. COCK AND W. F. JACKSON, PRINTERS, WOOLWICH.

# ADVERTISEMENT.

In undertaking the present work, the Author contemplated nothing more than a new edition of "Symons' Gauger," a work usually placed in the hands of young persons on their first appointment as Excise Officers; and it was not until he had proceeded a considerable way in revising that work, that he found it necessary to make such alterations and additions as gave to it altogether a different character and required a new title. This will in some measure account for the diversity of style and arrangement in the different parts of the work.

Although the work is no longer a *new edition*, it lays claim to no higher character than that of a *compilation*. Not only has the Author considered it his duty to borrow largely, from the various works on Gauging to which he could obtain access; but wherever he could meet with information, bearing the stamp of authority, he has not scrupled to make use of it; considering that he was thereby carrying out the principles laid down in the reports recently made to Government upon this important branch of the revenue. If, in any instance, he has omitted to acknowledge the authority used, he hopes it will be attributed to inadvertence, rather than to any design of arrogating to himself the honour due to others.

To his friend Thomas Julians, Esq., 1st Class Surveying General Examiner, who deservedly ranks high among the "*working* bees" in this useful hive of the Commonwealth, the author begs in an especial manner to make his acknowledgements for the great assistance given in every part of this laborious and difficult compilation.

Although the greatest care has been exercised in the calculations and tables contained in these pages, each of which has been checked, not only by the author, and by at least one practical officer, but also by WILLIAM RUTHERFORD, ESQ. F.R.A.S. of the Royal Military Academy, Woolwich, whose valuable assistance will be recognized in many of the mathematical suggestions; it is not to be expected that the first edition of a work of this description can be without errors of greater or less magnitude. The author therefore requests, that, when any such are discovered, or whenever any suggestions occur likely to render the work more generally useful, they may be communicated to the publisher, in order that they may be noticed in a future edition, or in a supplementary publication.

# CONTENTS.

## BOOK I.

CONTAINING SCIENTIFIC AND OTHER INFORMATION CONNECTED
WITH THE BUSINESS OF AN EXCISE OFFICER,
INCLUDING THE ART OF GAUGING.

### CHAPTER I.—ARITHMETIC.

PAGE.

PART I.—ARITHMETIC OF SIMPLE NUMBERS.................. 1
- 1.—Notation and Numeration.................. 1
- 2.—Addition.................. 3
- 3.—Subtraction.................. 4
- 4.—Multiplication.................. 5
- 5.—Division.................. 7
- 6.—Proportion; or, the Rule of Three.................. 9
- 7.—Vulgar Fractions.................. 10
- 8.—Decimals.................. 13
- 9.—Square Root.................. 16
- 10.—Cube Root.................. 19
- 11.—Progression.................. 22

PART II.—ARITHMETIC OF QUANTITIES.................. 23
- 1.—Weight, Measure, Time, and Money.................. 24
- 2.—Reduction.................. 29
- 3.—Compound Addition.................. 33
- 4.—Compound Subtraction.................. 34

PAGE.
5.—Compound Multiplication........ 35
6.—Compound Division........ 36
7.—Compound Proportion........ 37
8.—Practice........ 44
9.—*Arithmetical Tables*........ 48

## CHAPTER II.—MENSURATION.

PART I.—MENSURATION OF LINES AND ANGLES........ 62
1.—Of Right Lines........ 64
2.—Of Curved Lines........ 65
3.—Of Perpendicular Lines........ 65
4.—Of Parallel Lines........ 66
5.—Of Angles........ 67
PART II.—MENSURATION OF SUPERFICIES........ 70
1.—Of Triangles........ 72
2.—Of Quadrilaterals........ 78
3.—Of Polygons........ 82
4.—Of the Circle and its Sectors........ 85
5.—Of the Ellipsis, Parabola, and Hyperbola........ 95
6.—Of Irregular and Doubtful Curves........ 101
PART III.—MENSURATION OF SOLIDS........ 112
1.—Of Prisms........ 114
2.—Of Pyramids and their Frustums........ 123
3.—Of the Prismoid and Wedge........ 131
4.—Of the Sphere and its Sections........ 136
5.—Of Spheroids, Conoids, and Spindles........ 140
6.—Of the Five Regular Bodies........ 147
7.—*Mathematical Tables*........ 148

## CHAPTER III.—GAUGING.

PART I.—THE SLIDING RULE........ 161
1.—Of the Lines A and B........ 162
2.—Of the Lines C and D........ 169
3.—Of Gauge Points........ 172
4.—Of the Line M D........ 176
5.—Of the Line X........ 179
6.—Of the Variety-Lines........ 180
7.—Of the Ullage-Lines........ 180

PAGE
PART II.—GAUGING OPEN VESSELS .......... 182
1.—Of Regularly Formed Vessels .......... 183
2.—Of Vessels whose Forms are nearly regular .......... 187
3.—Of Irregular Vessels .......... 198
4.—Of Stills .......... 212
PART II.—CASK GAUGING AND ULLAGING .......... 218
1.—Of the Diagonal Rod .......... 218
2.—Of the different varieties of Casks .......... 220
3.—Of taking the Dimensions .......... 224
4.—Of finding the Content .......... 230
5.—Of Ullaging .......... 236
6.—Of Inching Casks .......... 239
7.—*Gauging Tables* .......... 240

# BOOK II.

## CONTAINING AN ACCOUNT OF THE EXCISE ESTABLISHMENT AND OF THE DUTIES UNDER THE MANAGEMENT OF THE EXCISE COMMISSIONERS.

### CHAPTER I.—THE EXCISE ESTABLISHMENT.

PART I.—OF THE BOARD OF COMMISSIONERS .......... 247
PART II.—THE SURVEYING DEPARTMENT .......... 248
1.—Of the Officers' Appointment; or, Order for Instructions. 248
2.—Of Expectants .......... 249
3.—Of Assistants and Supernumeraries .......... 250
4.—Of Surveying Officers .......... 250
5.—Of Examiners .......... 252
6.—Of Supervisors .......... 253
7.—Of Collectors .......... 253
8.—Of Surveying General Examiners .......... 254
9.—Of the Country Establishment .......... 255
10.—Of the London Establishment .......... 274
11.—Of the Order of Promotion .......... 275
12.—Of the Privileges of Excise Officers .......... 277
13.—Of Superannuation Deductions and Allowances .......... 278

PAGE.

## CHAPTER II.—EXCISE DUTIES.

PART I.—GENERAL REGULATIONS, &c. 279
1.—Of the Origin, &c. of the Excise Duties 279
2.—Of the General Course of Survey for charging the Duty 281
3.—Of the Entry of Places and Utensils 285
4.—Of Licences 286
5.—Of Permits 286
6.—Of Exporting Goods on Drawback 287
7.—Of Prosecutions for recovery of Duties and Penalties 288
8.—Of Complaints of Overcharge 289
PART II.—ALPHABETICAL ARRANGEMENTS OF DUTIES, &c. 290
1.—Auctions 290
2.—Beer and Cider 293
3.—Beet-Root Sugar 296
4.—Bricks 297
5.—Coffee, Tea, Cocoa, Nuts, Chocolate and Pepper 299
6.—Glass 300
7.—Hops 308
8.—Licences 310
9.—Malt 311
10.—Paper 320
11.—Passage Vessels 325
12.—Post Horses 326
13—.Soap 328
14.—Spirits 335
15.—Sugar 350
16.—Sweets 350
17.—Tobacco and Snuff 350
18.—Vinegar 352
19.—Wine 354

# SUBJECT MATTER OF THE PRINCIPAL TABLES, &c.

PAGE
Arithmetical Tables - - - - 2, 3, 5, 13, 17, 19
Tables of money, weights, and measures - 48, 50, 52, 54, 56, 57, 58, 60
Fractions and decimal parts of a pound sterling—a pound avoirdupois—a gallon—and a bushel - - - 49, 50, 52, 54
Tables for reducing inches into pound's weight avoirdupois—gallons—and bushels - - - - - - 51, 53, 55
Table of factors for salaries - - - - - - 49
Table of factors for converting old measure into new - - - 56
Table for finding the number of days between one month and another 58
Table of specific gravities - - - - - - - 59
Table of the areas, in gallons, of semi-squares - - 148—152
Table of circular areas in gallons - - - - 155—160
Table of the areas of circular segments—regular polygons—and regular bodies - - - - 147, 152, 153, 154
Tables of factors, divisors, and gauge points - - - 57, 173
Table for calculating the net bushels of malt to be entered on the specimen - - - - - - 240, 241
Tables for reducing spirits to different strengths - - - 242
Table of a diagonal line for cask gauging - - - - 243
Tables of the areas of the head and bung diameters of casks, and of the differences between the diameters - - - 244, 245
Tables of the different forms and dimensions of casks - 220, 246
Tables of names of the Commissioners and principal officers - 247
Schemes of collections and districts in the United Kingdom - 256—273
Table of duties, licences, drawbacks and allowances - 279

## EXPLANATION OF THE SIGNS USED IN BOOK I.

| | | | |
|---|---|---|---|
| $+$ | signifies *plus*, or addition. | $=$ | signifies equality. |
| $-$ | " *minus*, or subtraction. | $: \, :: \, :$ | " proportion. |
| $\times$ | " multiplication. | $\sqrt{}$ | " square root. |
| $\div$ | " division. | $\sqrt[3]{}$ | " cube root. |

Thus $4 + 3$ denotes that 3 is to be added to 4.

$6 - 4$ denotes that 4 is to be subtracted from 6.

$8 \times 2$ denotes that 8 is to be multiplied by 2.

$9 \div 3$ denotes that 9 is to be divided by 3.

$5 + 6 = 11$ shows that the sum of 5 and 6 is equal to 11.

$3 : 6 :: 12 : 24$ is expressed thus; 3 is to 6, as 12 is to 24.

$\sqrt{5}$ denotes the square root of the number 5.

$\sqrt[3]{6}$ denotes the cube root of the number 6.

A number written over the right of another in a smaller character, is called an *exponent* or *index*, and denotes that the number is to be repeated with signs of multiplication, as many times as are represented by the smaller character, thus:

$5^2$ denotes $5 \times 5$, or that the number 5 is to be squared.

$6^3$ denotes $6 \times 6 \times 6$, or that the number 6 is to be cubed.

A *vinculum* or line drawn over numbers connected by signs, or the inclosing of such between parenthetical characters, denotes that they are to be taken as one, thus;

$\overline{8 + 6} \div 7$, or $(8 + 6) \div 7$ denotes that the sum of 8 and 6 is to be divided by 7.

$\overline{24 - 3} \times 8$, or $(24 - 3) \times 8$ is the same as $21 \times 8 = 168$.

# THE

# EXCISE OFFICER'S MANUAL.

## BOOK I.

CONTAINING SCIENTIFIC AND OTHER INFORMATION CONNECTED WITH THE BUSINESS OF AN EXCISE OFFICER, INCLUDING THE ART OF GUAGING.

## CHAPTER I.

## ARITHMETIC.

The term "Arithmetic" is derived from the Greek, and signifies the art of numbering and of calculating in numbers. It may be considered under two heads: 1. Arithmetic of Simple Numbers. 2. Arithmetic of Quantities.

### PART I.—ARITHMETIC OF SIMPLE NUMBERS.

The fundamental rules of Arithmetic are Numeration, Addition, Subtraction, Multiplication, and Division. Upon these others are founded, which, for the purposes of the present Treatise, may be classed under the heads of Proportion, or, Rule of Three, Vulgar Fractions, Decimals, Square Root, Cube Root, and Progression.

### 1. *Notation and Numeration.*

NOTATION is the art of expressing numbers in figures.

Numeration is the art of reading or enumerating numbers when expressed in figures.*

TABLE.

| Hundreds of Millions | Tens of Millions | Millions | Hundreds of Thousands | Tens of Thousands | Thousands | Hundreds | Tens | Units |
|---|---|---|---|---|---|---|---|---|
| 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|  | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
|  |  | 9 | 8 | 7 | 6 | 5 | 4 | 3 |
|  |  |  | 9 | 8 | 7 | 6 | 5 | 4 |
|  |  |  |  | 9 | 8 | 7 | 6 | 5 |
|  |  |  |  |  | 9 | 8 | 7 | 6 |
|  |  |  |  |  |  | 9 | 8 | 7 |
|  |  |  |  |  |  |  | 9 | 8 |
|  |  |  |  |  |  |  |  | 9 |

---

* For the purpose of expressing numbers, we make use of ten signs or characters, and by these ten signs we can express all numbers, however large or small, by a very simple and ingenious arrangement.

These figures, signs, or characters, are as follows :—

| | | | | |
|---|---|---|---|---|
| 1 one | 3 three | 5 five | 7 seven | 9 nine |
| 2 two | 4 four | 6 six | 8 eight | 0 cipher |

The first nine are called *significant figures*, as distinguished from the cipher, which is of itself an insignificant number. Besides this value of those figures, they have also another or *local value*, which depends on the place they stand in when joined together, as in the above table, where any figure in the first place (reckoning from right to left) denotes only its own simple value; but any figure in the second place denotes ten times its simple value; and any figure in the third place, a hundred times its simple value, and so on: the value of any figure in each successive place being always ten times its former value.

Thus, in the number 444, the 4 in the first place denotes only 4 units, or simply 4; 4 in the second place signifies 4 tens, or forty; and 4 in the third place, four hundred; so that the whole number is read thus—four hundred and forty-four.

The cipher, 0, though signifying nothing of itself, when joined on the right hand side to other figures, increases their value in the same tenfold proportion; thus, 4 signifies only four; but 40 denotes 4 tens, or forty; and 400 is four hundred, and so on.

For the more easily reading of large numbers, they are divided into periods and half periods, each half period consisting of three figures, the first period being named units; the second, millions; the third, millions of millions or bi-millions, contracted to billions; the fourth, millions of millions of millions, or tri-millions, contracted to trillions, and so on. The first part of any period is so many units of it, and the latter part, so many thousands, as is shewn in the following table:—

**Rule for Numeration.**—Divide the number into periods and half-periods from right to left; then begin at the left hand, and read the figures with the names set to them in the tables.*

**Rule for Notation.**—Write every figure in its proper place, and supply vacant places with ciphers.†

## 2. *Addition.*

**Addition** is the method of finding a sum which shall be equal to two or more quantities taken together.

**Rule.**—Place units under units, tens under tens, &c, and draw a line under them. Add the figures in the units column, and find how many times ten that sum contains; set down the remainder, if any, at the foot of the column; and for every 10 in that sum, carry 1 to the next column. Proceed thus with every remaining column, and under the last write down the full sum.

| Periods | Quadrillions. | | Trillions. | | Billions. | | Millions. | | Units. | |
|---|---|---|---|---|---|---|---|---|---|---|
| Half-per. | th. | un. | th. | un. | th. | un. | th. | un. | th. | un. |
| Figures. | 123 , | 456; | 789 , | 098; | 765 , | 432; | 101 , | 234; | 567 , | 890. |

---

* EXAMPLES IN NUMERATION.

Express in words the following numbers, viz.

56
510
9,019
12,060
27,592
670,421
3,456,073
800,096,021

† EXAMPLES IN NOTATION.

Set down in figures the following numbers:—

Fifty-six; five hundred and ten; nine thousand and nineteen; twelve thousand and sixty; twenty-seven thousand five hundred and ninety-two; six hundred and seventy thousand four hundred and twenty-one; three millions four hundred and fifty-six thousand and seventy-three; eight hundred millions ninety-six thousand and twenty-one.

**Note.**—The examples here, and in some other rules, will be found to be reciprocally the answers to each other.

**Proof.**—Begin at the top and add together all the rows of numbers downwards, in the same manner as they were before added upwards; then if the two sums agree, it may be presumed the work is right.*

## 3. *Subtraction.*

**Subtraction** is the method of taking a less number from a greater, in order to find their difference.

**Rule.**—Place the less number under the greater,†

---

* EXAMPLES IN ADDITION.

| (1.) | (2.) | (3.) | (4.) |
|---|---|---|---|
| 12 | 123 | 1234 | 12345 |
| 21 | 132 | 1342 | 12354 |
| 11 | 213 | 1432 | 12543 |
| 22 | 231 | 2341 | 15432 |
| 10 | 113 | 2431 | 15234 |
| 76 | 812 | 8780 | 67908 |

(5.) 36 + 24 + 48 + 96 + 84 + 72 + 12 + 60 = 432.

(6.) 734912 + 1579134 + 1491356 + 1891356 + 1864290 + 1357828 = 8918876.

(7.) 1864290 + 735730 + 913578 + 690428 + 1135782 + 913578 = 6253386.

(8.) The net receipts of the revenue of excise in England, for 1835, were as follows:—Auctions, £211,896; bricks, £391,213; glass, £611,718; hops, £324,792; licenses, £847,065; malt, £4,299,768; paper, £681,181; soap, £698,802; spirits, £2,155,511; vinegar, £25,871; tea, £59; what was the total amount? Ans. £10,247,876.

† EXAMPLES IN SUBTRACTION.

| | (1.) | (2.) | (3.) | (4.) | (5.) | (6.) | (7.) |
|---|---|---|---|---|---|---|---|
| From | 38 | 78 | 198 | 673 | 7183 | 846789 | 731804 |
| Take | 26 | 45 | 127 | 363 | 2102 | 242316 | 129714 |
| Differ. | 12 | 33 | 71 | 310 | 5081 | 604473 | 602090 |
| Proof | 88 | 78 | 198 | 673 | 7183 | 846789 | 731804 |

(8.) What is the difference between 98457683 and 59864287? Ans. 38593396.

(9.) What is the difference between 73001826 and 907394? Ans. 72094432.

(10.) What number is 7314 + 1641 + 3124 — 7187 equal to? Ans. 4892.

(11.) In 1831 the population of England consisted of 6376627 males and 6714378 females; Wales, of 394563 males and 411619 females; Scotland, of 1114816 males and 1250298 females; Ireland, of 3794880 males and 3972521 females; and the army and navy, &c., of 277017 males. How much does the female part of the population of Great Britain and Ireland exceed the male part? Ans. 390913.

units under units, tens under tens, &c., and draw a line under them; then begin at the right hand, and take each figure of the less number from the figure above it, and place the remainder directly under. When the lower figure is equal to the upper, write down a cipher; when greater than that above it, suppose 10 added to the upper figure; then subtract the lower figure from the sum; and add 1 to the next lower figure before you subtract it.

PROOF.—Add the two undermost numbers together; their sum will be equal to the uppermost when the work is right.

### 4. *Multiplication.*

MULTIPLICATION is a compendious method of finding the sum of any given number when repeated a certain number of times.

The number to be multiplied is called the *multiplicand*; the number by which we multiply is called the *multiplier*; and the amount is called the *product*.

TABLE.

| Twice 1 are 2 | 3 times 1 are 3 | 4 times 1 are 4 | 5 times 1 are 5 | 6 times 1 are 6 | 7 times 1 are 7 | 8 times 1 are 8 | 9 times 1 are 9 | 10 times 1 are 10 | 11 times 1 are 11 | 12 times 1 are 12 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.. 4 | 2.. 6 | 2.. 8 | 2..10 | 2.. 12 | 2.. 14 | 2.. 16 | 2.. 18 | 2.. 20 | 2.. 22 | 2.. 24 |
| 3.. 6 | 3.. 9 | 3..12 | 3..15 | 3.. 18 | 3.. 21 | 3.. 24 | 3.. 27 | 3.. 30 | 3.. 33 | 3.. 36 |
| 4.. 8 | 4..12 | 4..16 | 4..20 | 4.. 24 | 4.. 28 | 4.. 32 | 4.. 36 | 4.. 40 | 4.. 44 | 4.. 48 |
| 5..10 | 5..15 | 5..20 | 5..25 | 5.. 30 | 5.. 35 | 5.. 40 | 5.. 45 | 5.. 50 | 5.. 55 | 5.. 60 |
| 6..12 | 6..18 | 6..24 | 6..30 | 6.. 36 | 6.. 42 | 6.. 48 | 6.. 54 | 6.. 60 | 6.. 66 | 6.. 72 |
| 7..14 | 7..21 | 7..28 | 7..35 | 7.. 42 | 7.. 49 | 7.. 56 | 7.. 63 | 7.. 70 | 7.. 77 | 7.. 84 |
| 8..16 | 8..24 | 8..32 | 8..40 | 8.. 48 | 8.. 56 | 8.. 64 | 8.. 72 | 8.. 80 | 8.. 88 | 8.. 96 |
| 9..18 | 9..27 | 9..36 | 9..45 | 9.. 54 | 9.. 63 | 9.. 72 | 9.. 81 | 9.. 90 | 9.. 99 | 9..108 |
| 10..20 | 10..30 | 10..40 | 10..50 | 10.. 60 | 10.. 70 | 10.. 80 | 10.. 90 | 10..100 | 10..110 | 10..120 |
| 11..22 | 11..33 | 11..44 | 11..55 | 11.. 66 | 11.. 77 | 11.. 88 | 11.. 99 | 11..110 | 11..121 | 11..132 |
| 12..24 | 12..36 | 12..48 | 12..60 | 12.. 72 | 12.. 84 | 12.. 96 | 12..108 | 12..120 | 12..132 | 12..144 |
| 13..26 | 13..39 | 13..52 | 13..65 | 13.. 78 | 13.. 91 | 13..104 | 13..117 | 13..130 | 13..143 | 13..156 |
| 14..28 | 14..42 | 14..56 | 14..70 | 14.. 84 | 14.. 98 | 14..112 | 14..126 | 14..140 | 14..154 | 14..168 |
| 15..30 | 15..45 | 15..60 | 15..75 | 15.. 90 | 15..105 | 15..120 | 15..135 | 15..150 | 15..165 | 15..180 |
| 16..32 | 16..48 | 16..64 | 16..80 | 16.. 96 | 16..112 | 16..128 | 16..144 | 16..160 | 16..176 | 16..192 |
| 17..34 | 17..51 | 17..68 | 17..85 | 17..102 | 17..119 | 17..136 | 17..153 | 17..170 | 17..187 | 17..204 |
| 18..36 | 18..54 | 18..72 | 18..90 | 18..108 | 18..126 | 18..144 | 18..162 | 18..180 | 18..198 | 18..216 |
| 19..38 | 19..57 | 19..76 | 19..95 | 19..114 | 19..133 | 19..152 | 19..171 | 19..190 | 19..209 | 19..222 |
| 20..40 | 20..60 | 20..80 | 20.100 | 20..120 | 20..140 | 20..160 | 20..180 | 20..200 | 20..220 | 20..240 |

RULE I.—Place the multiplier under the multiplicand,* units under units, &c., and draw a line under them; multiply each figure in the multiplicand, first by the units of the multiplier, then by the other figures in their order, placing the first figure of each product directly under the figure by which it is multiplied, and carry 1 for every 10, as in Addition; the product, or the added products, as the case may be, will be the answer.†

RULE. II.—When the multiplier is the product of two or more numbers in the table, multiply by each of those parts successively, instead of the whole number at once.

RULE III.—If there be a cipher or ciphers at the right

---

* The multiplicand and multiplier are both called *factors* of the multiplication.

† EXAMPLES IN MULTIPLICATION.

(1.) Multiply 4606870 by 18.

| | |
|---|---|
| Multiplicand | 4606870 |
| Multiplier | 18 |
| | 36854960 |
| | 4606870 |
| Product | 82923660 |

(2.) Multiply 4606870 by 108.

| |
|---|
| 4606870 |
| 108 |
| 36854960 |
| 4606870 |
| 497541960 |

(3.) 2345678 × 47 = 110246866.
(4.) 8970681 × 96 = 861185376.
(5.) 763412 × 224 = 171004288.
(6.) 628547 × 576 = 362043072.
(7.) 2576983 × 486 = 1252413738.
(8.) 7167398 × 390 = 2795285220.
(9.) Multiply 680945681 by 4865 = 3312800738065.
(10.) Multiply 354269732 by 7364 = 2608842306448.
(11.) Multiply 739684386 by 9542 = 7058068411212.

EXAMPLES APPLICABLE TO RULE II.

(12.) Multiply 4096731 by 36.

| | |
|---|---|
| | 4096731 |
| 6×6=36. | 6 |
| | 24580386 |
| | 6 |
| Ans. | 147482316 |

(13.) Multiply 1173948 by 72.
Ans. 84524256.

(14.) Multiply 1236829 by 168.
Ans. 207787272.

(15.) Multiply 61835720 by 1320.
Ans. 81623150400.

of one or of both factors, multiply by the significant figures, and annex the ciphers to the product.

PROOF.—Make the former multiplicand the multiplier, and the multiplier the multiplicand; and if this product be equal to the former, the work may be presumed to be correct.

### 5. *Division.*

DIVISION is the method of finding how often one number is contained in another.

The number to be divided is called the ***dividend;*** the number we divide by is called the ***divisor;*** the number of times the dividend contains the divisor is called the ***quotient.***

RULE.—Place the divisor before the dividend, thus— 5 ) 18 (— ; find how often the divisor is contained in as many figures of the dividend as are just necessary, and

---

EXAMPLES APPLICABLE TO RULE III.

(16.) Multiply 746 by 5400000.

$$\begin{array}{r} 746\phantom{00000} \\ 5400000 \\ \hline 2984\phantom{00000} \\ 3730\phantom{000000} \\ \hline 4028400000 \\ \hline \end{array}$$

(17.) Multiply 84220000 by 220.

$$\begin{array}{r} 84220000 \\ 220 \\ \hline 16844\phantom{0000} \\ 16844\phantom{00000} \\ \hline 18528400000 \\ \hline \end{array}$$

There are several methods of shortening the operations, one of which, probably the most useful, is worked in the following manner:—

(18.) Multiply 71380164
By 27354

$$\begin{array}{r} 214140492\phantom{00} \\ 1927264428\phantom{000} \\ 3854528856 \\ \hline \text{Ans. } 1952533006056 \\ \hline \end{array}$$

Here we begin with the 3 in the middle; then 9 times its product will be the product for the 27 on the left; and again, 2 times this last will be the product for the 54 on the right. Care must be taken, however, to attend to the general rule of placing the first figure of each product straight below the first figure of its own multiplier.

(19.) Multiply 61370913 by 96488. Ans. 5921556653544.
(20.) Multiply 94324364 by 63672. Ans. 6005820904608.

place the number on the right, in the quotient; multiply the divisor by this number, and set the product under the figures of the dividend before mentioned; subtract this product from that part of the dividend under which it stands, and bring down the next figure of the dividend, or more if necessary, to join on the right of the remainder; divide this number, so increased, in the same manner as before; and so on, till all the figures are brought down and used. If it be necessary to bring down more figures than one to any remainder, in order to make it as large as the divisor, or larger, a cipher must be set in the quotient for every figure thus brought down more than one.

If the divisor does not exceed 12, the division may be expeditiously performed mentally, setting down the quotient only below the dividend.*

---

* EXAMPLES IN DIVISION.

(1.) Divide 96842976368 by 8.

8 ) 96842976368

Ans. 12105372046
8

Proof 96842976368

(2.) Divide 86429738048 by 11.

11 ) 86429738048

Ans. $7857248913\frac{5}{11}$
11

Proof 86429738048

(3.) $327015348753 \div 4 = 81753837188\frac{1}{4}$.

(4.) $613976423575 \div 6 = 102329403929\frac{1}{6}$.

(5.) $123456789081 \div 9 = 13717421009$.

(6.) $342738429647 \div 12 = 28561535803\frac{11}{12}$

When the divisor exceeds 12 the operation is performed thus:—

(7.) Divide 73697644 by 6428.

6428 ) 73697644 ( $11465\frac{624}{6428}$ Ans.
6428
9417
6428
29896
25712
41844
38568
32764
32140
Remainder 624

$11465\frac{624}{6428}$
6428
91724
22932
45866
68790
73697644 Proof.

(8.) Divide 98642975 by 7864.
Ans. $12543\frac{4823}{7864}$.

(9.) Divide 38769428 by 2976.
Ans. $13027\frac{1076}{2976}$.

(10.) Divide 58429735 by 4735.
Ans. $12339\frac{4570}{4735}$.

(11.) Divide 56743852 by 3969.
Ans. $14296\frac{3028}{3969}$.

(12.) Divide 96432864 by 7854.
Ans. $12278\frac{1452}{7854}$.

(13.) Divide 56876544 by 9216.
Ans. $6171\frac{4608}{9216}$.

## 6. *Proportion; or, the Rule of Three.*

THIS rule is an application of the doctrine of proportion to arithmetical purposes, whereby a number is found bearing the same proportion in a direct ratio to a given number which two other given numbers bear to each other. It is called the "Rule of Three" because, in each of its questions, three numbers at least are given; and, from its extensive use, it is called the *Golden Rule.*

RULE.—Multiply the second and third numbers together, and divide the product by the first number; the quotient is the answer sought, or the fourth number.*

---

When there are ciphers annexed to the divisor cut them off, and cut off as many figures from the dividend; annex these figures to the remainder.

EXAMPLES.

(14.) Divide 96735429 by 8000. Ans. $12091\frac{7429}{8000}$.

(15.) Divide 85329684 by 73000. Ans. $1168\frac{65684}{73000}$.

When the divisor is the product of two or more numbers none of which exceeds 12, divide successively by these numbers; and to find the remainder, multiply the last remainder into all the preceding divisors, (the last excepted,) adding the several remainders to the product to which they belong: thus,

(16.) Divide 48642764 by 315.

```
      5|48642764        5×7×9=315
       |--------
      7| 9728552............ 4
315 {  |--------
      9| 1389793..1×5   =   5
       |--------
       |  154421..4×7×5=140
       |--------         ---
              Remainder 149
```

(17.) Divide 38642736 by 576. Ans. $67088\frac{48}{576}$.

(18.) Divide 87341985 by 112. Ans. $779839\frac{71}{112}$.

(19.) Divide 64894229 by 224. Ans. $289706\frac{85}{224}$.

(20.) Divide 74838694 by 147. Ans. $509106\frac{112}{147}$.

When the divisor consists of several figures, and is in frequent use, it will be found expeditious, as well as safe, to make a table of the divisor, containing its different products when multiplied by every number from 1 to 9 inclusive. This will be found particularly useful in reducing solid inches to feet, gallons, or bushels. (See Reduction, *infra.*)

* EXAMPLES IN RULE OF THREE.

(1.) If 3 bears a direct proportion to 12, to what number will 9 bear a like direct proportion?

State the question thus:—

```
As 3 : 12 :: 9
         9
       ---
   3 ) 108
       ---
 Ans.   36
       ---
```

Here the fourth number, or answer, (36,) bears the same proportion to the second number, (12,) as 9, (the third number,) does to three (the first number); that is, it contains it three times, or it bears the same proportion to the third num-

## 7. *Vulgar Fractions.*

As any thing, however small, may still be supposed to be divided into any number of parts, so any number, however small, may be supposed to be divided by any other number, however large. Numbers which are supposed to be produced by such a division as is just referred to, are called *fractions*, or parts; and as one of such fractions or parts is less than the number 1, and as the number 1 is the smallest number that can be expressed in the common way of expressing numbers, fractions require a different method of notation. Still, however, they are numbers; and when the method of writing them, and also their nature, are understood, the operations of adding, subtracting, multiplying, and dividing may be performed with them on the same principles as with other numbers.[*]

---

ber (9) as the second number (12) does to the first number—namely, contains it four times. Had a value been given to the figures, as will be more fully shown under the head of Arithmetic of Quantities, it might perhaps have been better understood thus: If 3 bushels of malt cost 12s., what will nine bushels cost at the same rate? Ans. 36s.

(2.) If 6 : 24 : : 18. Ans. 72. (3.) If 56 : 589 : : 168. Ans. 1767.
(4.) If 888 : 50000 : : 1998. Ans. 112500. (*See* COMPOUND PROPORTION.)

[*] The value which the fraction expresses, or the number that it stands for, is the quotient that would arise from dividing its upper number or numerator, by its under number, or denominator, if that division could be performed. And this value does not depend upon the absolute greatness of either or both of the two numbers, but upon the greatness of the numerator compared with that of the denominator. The value of a fraction is therefore twofold, depending partly upon the numerator and partly upon the denominator; and it increases with increase of the numerator, but diminishes with increase of the denominator. It therefore follows, that to *add* to a fraction, we may either add to its numerator or subtract from its denominator; to *subtract* from a fraction, we may either subtract from the numerator or add to its denominator; to *multiply*, we may either multiply the numerator or divide the denominator; and to *divide*, we may either divide the numerator or multiply the denominator—the change, in every case, depending upon the comparative difference made between the numerator and denominator. In consequence of this property of fractions, we are enabled to change a fraction of any one denominator to any other; and thus fractions which cannot be compared or added in their original form, may be compared or added the same as other numbers.

A fraction, therefore, is a part or several parts of something considered as a whole, and is expressed by two numbers, one (the *numerator*) usually written above a small line, and the other (the *denominator*) written below the same: thus, $\frac{3}{8}$ is a fraction, signifying three eighths of one.

To change fractions of different denominations to the same denominator, multiply both numerator and denominator of each fraction by the denominators of all the other fractions; and to reduce a fraction to its lowest denomination, divide each term by the largest number that will leave no remainder.*

ADDITION. The general principle in every kind of Addition is, that only numbers of the same kind or denomination can be shortened into one sum. Hence,

1. To add a fraction to a number, annex it to the right: thus, the sum of 12 and $\frac{4}{7}$ would be $12\frac{4}{7}$.†

2. To add fractions, change them to the same denomination, and add the numerators.

---

* EXAMPLE IN VULGAR FRACTIONS.

(1.) Change $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{3}{4}$ to the same denominator.

Multiply both terms of $\frac{1}{2}$ by 3 and 4; both terms of $\frac{2}{3}$ by 2 and 4; and both terms of $\frac{3}{4}$ by 2 and 3.

Thus, $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{3}{4} = \frac{12}{24}$, $\frac{16}{24}$, and $\frac{18}{24}$, or $= \frac{6}{12}$, $\frac{8}{12}$, and $\frac{9}{12}$.

(2.) Reduce $\frac{216}{288}$ to its least term.

Divide the denominator by the numerator, and the remainder by the numerator; make each remainder the divisor of the former divisor, until there be no remainder: the last divisor will be the largest common divisor.

Thus 216 ) 288 ( 1 Common divisor 72 ) $\frac{216}{288}$ ( $\frac{3}{4}$
216
72 ) 216 ( 3 Lowest denomination, $\frac{3}{4}$.
216

† Expressions of this kind are called *mixed numbers;* they cannot be expressed simply as whole numbers, unless the numerator of the fraction can be divided by the denominator without leaving any remainder; but they may always be expressed simply as fractions, and the method of doing this is to multiply the number by the denominator of the fraction, add the numerator to the product, and make the sum numerator.

**SUBTRACTION.** This being the converse of Addition, will require the same preparation; and thus the rule for subtracting one fraction from another will be this:—

Change to the same denomination, as in Addition, then subtract the less numerator from the greater, and place the difference over the common denominator.[*]

**MULTIPLICATION.** It has been shown that a fraction is nothing else than the numerator divided by the denominator; hence, the product by a fraction will be the product by the numerator divided by the denominator; therefore to multiply by a fraction, multiply by the numerator and divide the product by the denominator.[†]

To multiply two or more fractions together, multiply the numerators for numerator of the product, and the denominators for denominator.

**DIVISION.** As Division is the opposite of Multiplication, it follows that, to divide by a fraction, we multiply by the denominator, and divide the product by the numerator.[‡]

---

EXAMPLE IN ADDITION OF VULGAR FRACTIONS.

(3.) Required the sum of $2\frac{1}{3}$, $\frac{4}{5}$, and $\frac{1}{2}$ of $\frac{3}{4}$?

First, $2\frac{1}{3}=\frac{7}{3}$, and $\frac{1}{2}$ of $\frac{3}{4}=\frac{3}{8}$, therefore the fractions are $\frac{7}{3}$, $\frac{4}{5}$, and $\frac{3}{8}$.

$$\left.\begin{array}{r}7\times5\times8=280\\4\times3\times8=\ 96\\3\times3\times5=\ 45\end{array}\right\}\text{Numerators}$$

$3\times5\times8=120$ Common denominator.

Then $\frac{280+96+45}{120}=\frac{421}{120}=3\frac{61}{120}=$ the sum.

[*] The cases that most usually occur in practice are the addition and subtraction of small fractions (that is, fractions of which the terms are small) connected with whole numbers; and these may be added or subtracted separately, taking care, in Addition, to take in with the whole numbers any ones that may be obtained from the sum of the fractions; and in Subtraction, when the fraction belonging to the smaller number exceeds that belonging to the larger, 1 must be added to the smaller fraction; and, to compensate it, 1 must be carried to the units of the smaller number.

[†] EXAMPLE IN MULTIPLICATION OF VULGAR FRACTIONS.

(4.) To multiply 12 by $\frac{3}{4}$, multiply 12 by 3, and divide the product by 4. In this way the product will be 36 divided by 4—that is, 9.

[‡] EXAMPLE IN DIVISION OF VULGAR FRACTIONS.

(5.) To divide 9 by $\frac{3}{4}$, multiply 9 by 4 and divide the product by 3; the quotient will be 12.

## 8. *Decimals.*

A DECIMAL is a fraction* the denominator of which is always 10, 100, 1000, &c.—that is, 1 with a cipher or a number of ciphers annexed, the denominator not being written under the numerator, as in Vulgar Fractions, but implied by a point or dot placed before the numerator, thus, ·1 is $\frac{1}{10}$; ·55 is $\frac{55}{100}$ths, &c.

In Decimal Fractions, the value of the places decrease *in a tenfold proportion below unity*, in the same manner as they increase in whole numbers above unity: thus,

| | Millions | Hundreds of Thousands | Tens of Thousands | Thousands | Hundreds | Tens | Units | Tenth parts | Hundredth parts | Thousandth parts | Tenth of Thousandth parts | Hundreth of Thousandth parts | Millionth parts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Places.... | 7 | 6 | 5 | 4 | 3 | 2 | 1· | 1 | 2 | 3 | 4 | 5 | 6 |
| Examples | 4 | 4 | 4 | 4 | 4 | 4 | 4· | 4 | 4 | 4 | 4 | 4 | 4† |

---

* Though the way of expressing fractions, and performing the operations of Arithmetic with them, as explained in the preceding section, be that which accords strictly with the way in which fractions are naturally produced, yet it is attended with considerable trouble, in consequence of there being as many denominations of fractions as there can be different numbers used for denominators. In order to avoid this trouble, an artificial form of fractions has been invented, in which, as in whole numbers, the same figures of the numerators are always of the same denomination, and can be added or subtracted without any change. Fractions in this form are called *Decimals*.

They are so called because the denominator always consists of as many tens (*decems*) multiplied together as there are figures in the numerator. And this not only prevents the trouble of changing the fractions, but also prevents the necessity of writing the denominations. A decimal, when it stands alone, is distinguished from a whole number by having a point ( · ) on the left of it. Thus, 5 is a whole number, and means *five;* but ·5 is a decimal, and means *five-tenths*, or *one-half.* When a number consists partly of whole numbers and partly of decimals, the distinction is made by putting the point ( · ) between the one and the other: thus, 5·5 means *five* and *five-tenths*, or *five* and *one-half.*

† The dot being placed after the unit figure, to distinguish the value of

Ciphers, in decimal fractions, perform the same office as they do in whole numbers—that is, they fill up vacant places, and, by that means, keep the significant figures in their proper stations, and preserve their just value. But it is important to recollect, that ciphers added to decimals on the right hand, cause no difference in their value; although when placed on the left, they diminish the value of the decimal in a tenfold proportion.

*To change a vulgar fraction to a decimal*, or, in other words, to ascertain the value or notation of a fraction when expressed in a decimal, it is only necessary to find some number which, multiplied by the denominator, would produce 1, with ciphers annexed; and the product of this number by the numerator will be the decimal; or (which is the same thing) add a cipher or ciphers to the numerator, and divide by the denominator, and then the quotient will be the decimal.*

---

the places, all the places to the left hand of the dot are whole numbers, and all to the right, decimals.

* Because decimals increase their value towards the left hand, and decrease their value towards the right hand, in the same tenfold proportion with integers, or whole numbers, they may be annexed to whole numbers, and worked in all respects as whole numbers; and if simple Arithmetic be well understood, there is little more to be learned than the placing of the dot or separating point, the rule for which ought to be well attended to.

EXAMPLES IN REDUCTION OF DECIMALS.

(1.) Reduce $\frac{1}{2}$ to a decimal.

$$\begin{array}{r} 2\,)\,1{\cdot}0 \\ \hline \cdot 5 \text{ Ans.} \end{array}$$

(2.) Reduce $\frac{5}{11}$ to a decimal.

$$\begin{array}{r} 11\,)\,5{\cdot}00 \\ \hline \cdot\dot{4}\dot{5} \end{array}$$

(3.) What are the decimals of $\frac{1}{4}$, $\frac{3}{4}$, and $\frac{7}{8}$ respectively?

Ans. ·25, ·75, and ·875.

(4.) What is the decimal of $\frac{124}{1264}$? Ans. $\cdot 0\dot{9}81012658227 8\dot{4}$.

A *Terminate Decimal* is one which extends to a limited number of places, as ·4, ·35, ·625.

*Interminate Decimals* are those which extend without end, and are divided into four kinds:—

| 1st.<br>Pure Repeaters. | 2nd.<br>Mixed Repeaters. | 3rd.<br>Pure Circulates. | 4th.<br>Mix. Circulates. |
|---|---|---|---|
| $\cdot\dot{2}2222$ | $\cdot451\dot{6}$ | $\cdot\dot{5}\dot{4}5454$ | $\cdot5\dot{2}\dot{7}$ |

**Addition and Subtraction.** Care must be taken that the points which mark the beginning of the decimals be arranged under each other, and that only those figures which are equally distant from those points, whether on the right hand or on the left, be added or subtracted; and on this being attended to, the operations are performed precisely in the same manner as with whole numbers.*

**Multiplication and Division.** These operations are also performed with decimals precisely in the same manner as with whole numbers, the only difficulty being

---

Repeaters are indicated by a *point* over them; and Circulates, by a *point* over the first and last figures of the circle. The figures on the left of the repeating ones are called the *finite part*.

Much time may frequently be saved by committing a few of the principal decimals, with their corresponding vulgar fractions, to memory. For instance, if the learner recollect that ·25 = ¼, then as 5s. is ¼ of a pound sterling, 3 inches ¼ of a foot, 6 hours ¼ of a day, &c., he would not hesitate to write ·25 for any of these. On the contrary, he would instantly conclude, if he knew that ·75 = ¾, that ·75*l.* must be 15s. Then, also, ·5 being equal to half any whole, ·5*l.* must be 10s., ·5cwt. must be 2qrs., and ·5lb. must be 8oz. avoirdupois. The following are a few of the leading decimals, which will greatly assist the learner if he have them always at command; others will be found in the Tables at the end of this chapter:—

| | | |
|---|---|---|
| $\cdot 25 = \frac{1}{4}$ | $\cdot 125 = \frac{1}{8}$ | $\cdot 333\dot{3} = \frac{1}{3}$ |
| $\cdot 5 = \frac{1}{2}$ | $\cdot 1 = \frac{1}{10}$ | $\cdot 2 = \frac{1}{5}$ |
| $\cdot 75 = \frac{3}{4}$ | $\cdot 05 = \frac{1}{20}$ | $\cdot 083\dot{3} = \frac{1}{12}$ |

—*Taylor's Sequel.*

TO REDUCE A DECIMAL TO A VULGAR FRACTION.

To reduce a decimal to a vulgar fraction, the decimal may be written over its proper denominator, and then the fraction reduced to its lowest terms, as in page 11: thus, $\cdot 175 = \frac{175}{1000} = \frac{7}{40}$

* EXAMPLES IN ADDITION AND SUBTRACTION OF DECIMALS.

(5.) Add ·47, ·62, and ·27 together.

·47
·62
·27
Sum 1·36

(6.) Add 51·43, 90·02, and ·076 together.

51·43
90·02
·076
Sum 141·526

(7.) From 8·42 take 4·6.

8·42
4·6
Rem. 3·82

(8.) From 1 take ·954.

1
0·954
Rem. ·046

to determine how much of the result ought to be considered as decimals, and how much as whole numbers—that is, in what place of the product or quotient the dot or point should be inserted.*

## 9. *Square Root.*

THE *root* of any given number or power is such a number as, being multiplied by itself a certain number of times, will produce such given number or power. Any number which, being multiplied by itself once, produces a square number, is called the *square root* of such number.*

---

* In Multiplication this is easy, for we have only to count the number of decimal places (that is, the number of figures after or at the right of the point) that are in the multiplicand and multiplier, and allow as many decimal places as there are in both; and if the product (which may happen sometimes to be the case) shall not have as many figures, the deficiency must be made up by prefixing ciphers to the left, and placing the point before these.

In Division there is a little more difficulty. The general principle, indeed, is sufficiently simple—the dividend, being the product of the divisor and quotient, must contain as many places of decimals as both of them; and therefore, when the quotient is found, *as many figures must be pointed off in it for decimals, as the decimal places in the dividend exceed those in the divisor.* But as the quotient is not found until the division be performed, and as ciphers have sometimes to be put at the beginning of it, to make up the proper number of decimal places, it will be necessary to consider how many places will be required, so as to allow space for a sufficient number of ciphers in the dividend and quotient.

EXAMPLES IN MULTIPLICATION AND DIVISION OF DECIMALS.

(9.) Multiply ·2761 by ·35.

·2761
·35
13805
8283
·096635

(11.) Divide 527·64 by 24·8.

24·8 ) 527·64 ( 21·2
496
316
248
684
496
188

(10.) Multiply ·04764 by ·025.

·04764
·025
23820
9528
·00119100

(12.) Divide 15004 by ·929.

·929 ) 15004·000 ( 16150
929
5714
5574
1400
929
4710
4645
650

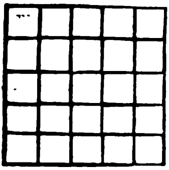
### TABLE OF ROOTS AND SQUARES.

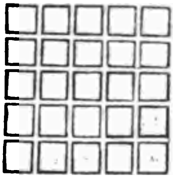
| Roots | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Squares | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 |

To *square a number* is to multiply that number by itself.

To *extract the square root of a number* is to find a number which, multiplied by itself, will produce the number proposed.

---





* Suppose a piece of paper, of the form in the margin, is 5 inches long and 5 inches wide, it is plain from the figure, that it may be cut into 25 square inches; for if we cut a slip an inch wide from any side of it, and divide it into 5 equal parts, each part will be an inch long and an inch wide—that is, each of these will be a square inch. But the whole paper may be cut into as many such slips as it is inches in breadth; this piece of paper, therefore, may be cut into 5 such slips, and each slip will contain 5 square inches: thus the whole would be cut into 5 times 5, or 25 square inches—that is, to adopt the more usual terms, the area or content of the paper will be 25 square inches. This area is obviously found by multiplying the number of square inches in each slip by the number of slips, or, in other, words by multiplying the inches which the paper measures in length by the inches it measures in breadth. But, in this case, when the length and breadth are equal, the content must be found by multiplying the number of inches in either side by itself. Now, geometricians would call a piece of paper like that we have been considering, a *square;* and hence the number that expresses the contents of a square is denominated a *square number.* It is plain from the preceding remarks, that this number will always be the product of some number multiplied by itself. The product of any number multiplied by itself is called a *square,* or the square of the number by which it is produced: thus, 25 is the square of 5. The number which is multiplied by itself to produce a square number, is called the *square root* of the product: thus, 5 is the square root of 25.—*Taylor's Sequel.*

RULE.—Divide the given number into periods of two figures each, beginning at the place of units on the right hand, and pointing toward the left in integers, and toward the right in decimals; find the greatest square number contained in the left hand period, place its root in the quotient, subtract its square from the period, and to the remainder bring down the second period for a dividend; double that part of the root already found, and insert it on the left hand of the dividend; divide by it, omitting the units place; set the result in the quotient, and annex it also to the divisor; multiply the divisor thus completed by the last figure placed in the root; subtract the product from the dividend, and to the remainder bring down the third period for a new dividend; proceed in the same manner till all the periods are brought down.*

---

* When the proposed number is included in the above table of squares, its root is found by inspection: thus, the square root of 16 is 4; and of 36, is 6. When the number is large, it becomes necessary to operate according to the above rule, it being recollected, that the root consists of as many whole numbers and decimals as there are periods belonging to each; and that if there be a remainder after all the periods are used, the operation may be continued to any extent by adding ciphers. If the number to be extracted be entirely decimal, a cipher may be put in the units place of integers, and the first point placed over it.

### EXAMPLES IN SQUARE ROOT.

(1.) Required the square root of 15376.

$\dot{1}5\dot{3}7\dot{6}$ ( 124 Root.
1
22 ) 53
44
244 ) 976
976
...

Proof 124 × 124 = 15376 Square.

(2.) Required the square root of 63214·713.

$\dot{6}3\dot{2}1\dot{4}\cdot7\dot{1}3\dot{0}$(251·42 Root required
4
45 ) 232
225
501 ) 714
501
5024 ) 213·71
200·96
50282 ) 12·7530
10·0564
2·6966

251·42
251·42
50284
100568
25142
125710
50284
63212·0164
2·6966
Proof 63214·713

**Proof.**—Multiply the root by itself, and add the last remainder, if any, to the product: the sum will equal the number proposed.*

## 10. *Cube Root.*

A *cube number* is a number produced by multiplying a number by itself, and that product again by the first number.

TABLE OF ROOTS AND CUBES.

| Roots | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Cubes | 1 | 8 | 27 | 64 | 125 | 216 | 343 | 512 | 729 |

Roots of vulgar fractions are found by extracting the root of the numerator for a new numerator, and the root of the denominator for a new denominator; but if that cannot be done exactly, the vulgar fraction may be reduced to a decimal, and worked as before. Mixed numbers may be reduced either to improper fractions or decimals, and then extracted.

### TO FIND A GEOMETRICAL MEAN.

A useful application of this rule is in finding a mean proportional between two given numbers. This is done by multiplying such numbers together, and extracting the square root of the product, which is the mean proportional between them: thus,

(3.) Required a geometrical mean proportional betwen 36 and 64.

$64 \times 36 = 2\dot{3}0\dot{4}$ ( 48 Ans.
16
88 ) 704
704
...

(4.) Required a geometrical mean proportional between 2·5 and 57·6.

$57{\cdot}6 \times 2{\cdot}5 = \dot{1}4\dot{4}0\dot{0}$ (12 Ans.
1
22 ) 44
44
..

### GUAGE POINTS.

This rule is also extensively used in the construction and application of the *sliding-rule*, the marks upon which technically called *guage-points*, being nothing more than the square roots of the number of inches which, in the ordinary mode of calculation, it is necessary to use as divisors for reducing solid inches into gallons, bushels, &c. (See the description and use of the sliding-rule; and also the tables of roots, squares, guage-points, &c., *infra.*)

* By means of the square root we readily find the fourth root, or the eighth root, or the sixteenth root, &c.—that is, the root of any power whose index is some power of the number 2; namely, by extracting so often the square root as is denoted by that power of 2—that is, two extractions for the fourth root, three for the eighth root, and so on. Thus, to find the fourth root of the number 21035·8, it would require two operations as follows:—

$\dot{2}1\dot{0}3\dot{5}{\cdot}8\dot{0}0\dot{0}$ ( $\dot{1}4\dot{5}{\cdot}0\dot{3}7\dot{2}3\dot{7}$ ( 12·0431407, the fourth root.

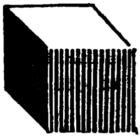
To *cube a number* is to multiply it twice by itself.*

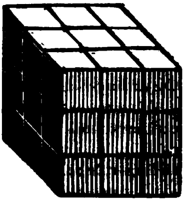
To *extract the cube root of a number* is to find a number which, multiplied by itself, and that product again by itself, will produce the proposed number.†

Rule.—Divide the given number into periods of three figures each, beginning at the right hand in integers, and pointing toward the left; but in decimals, begin at the place of thousands, and point toward the right; find the greatest cube number in the left hand period, and place the root of that number as the first figure of the root sought; subtract the number itself from the said period, and to the remainder bring down the next period for a dividend; on the left of the dividend write three times the square of the first quotient figure for a trial divisor, by which, omitting the two figures to the right hand of the

---

* If a piece be sawn out of a tree of a square form, an inch long, an inch wide, and an inch thick, it would be what is called a *solid inch*, as in the margin; and the geometrical name of such a solid is a *cube*. Now, if we suppose a piece of timber of the form of a cube is 3 inches long, 3 inches wide, and 3 inches thick, it is plain, from inspecting the figure, that it may be cut into 3 oblong pieces, each 3 inches wide, 3 inches long, and 1 inch thick. Each of these oblong pieces is a square of the side, and may be divided into 9 pieces, each 1 inch long, wide, and thick, or into 9 solid inches. But there are as many of these oblong pieces as there are inches in thickness; and, consequently, the whole cube may be divided into 9 × 3, or 27 solid inches. Hence it appears, that the content of a cube is found by multiplying the square of its side by the root; or, which is the same, by multiplying the side by itself, and that product again by the side: thus, 3 × 3 = 9, and 9 × 3 = 27.





† When the proposed number is included in the above table, its root is found by inspection: thus, the cube root of 27 is 3. When the root is large, it is necessary to operate according to the above rule, which is extracted from the last edition of "Gray's Arithmetic," by Mr. Rutherford, of the Royal Military Academy, Woolwich. The usual method of extracting the cube root, as inserted even in our best books of arithmetic, is very tedious, especially when more than three or four figures are to be found.

dividend, find the next figure in the root; on the left of the trial divisor, and one line lower, write the quotient figure thus found in the place of units, and three times the part of the root formerly found, write in the place of tens, hundreds, and so on; multiply this last number by the last figure in the root, and place the result as it arises below the trial divisor, but two places further to the right, and the sum of these two lines will be the complete divisor; multiply the complete divisor by the quotient figure, placing the product below the dividend; subtract, and place down another period; under the complete divisor write the square of the last quotient figure, and the sum of this square and the numbers in the two lines immediately above it, will give another trial divisor, with which proceed as before.*

---

* When the trial divisor is not contained in the dividend, omitting the two figures on the right, affix two ciphers to the divisor and another period to the dividend.

EXAMPLE.

What is the cube root of 477?

By the preceding table of cube numbers, the integer figure of the root will be found to be 7; and by an attentive perusal of the annexed worked example, the learner will find that the process is not much more difficult than that of extracting the square root. The numbers 218, 2341, &c., in the left column, are easily found by writing the last found figure of the root in the place of units, and multiplying the former figures of the root by 3, and writing the product as it arises to the left of the units figure. The last figures of the root are found simply by division, since the figures in the left of the divisor remain unchanged in the succeeding steps of the operation. (See the tables of roots, cubes, &c., *infra.*)

```
7........49
         —         477(7·81338923
         49........343   { Root
         49        ———   { sought.
        ———        134000
         147
218...... 1744
        ———
         16444......181552
             64     ———
        ————          2448000
         18252
2341....     2341
        —————
         1827541......1827541
               1      ————
        —————           620459000
         1829883
23433....     70299
        —————————
         183058599....549175797
                 9    ——————————
        ———————— ——     71283203000
         183128907
234393..       703179
        ——————————
         18313593879...54940781637
                   9    ———————————
        ———————— ————   163424,21363
         18314,29706|7  146514
                        ———————
                          16910
                          16483
                        ———————
                            427
                            366
                           ————
                             61
                             55
```

## 11. *Progression.*

WHEN several numbers follow in succession they form a *series.*

When a series of numbers increases or decreases in a regular manner, they form a *progression.*

A series of numbers which increases by a regular addition, or decreases by a regular subtraction, is called an *arithmetical progression.*

A series of numbers which increases by a regular multiplication, or decreases by a regular division, is termed a *geometrical progression.*[*]

---

[*] Thus, 1, 3, 5, 7, 9, is an arithmetical progression, consisting of 5 terms, whose common difference is 2, and whose extremes are 1 and 9; and 1, 2, 4, 8, 16, is a geometrical progression, consisting of 5 terms, whose ratio is 2, and extremes 1 and 16.

The last term of an arithmetical series may be found by multiplying the number of terms, diminished by unity, by the common difference, and adding the product to, or subtracting it from, the first term of the series, according as the series increases or diminishes. And the sum of all the terms may be found by multiplying the sum of the extremes by half the number of terms, or multiplying half the sum of the extremes by the number of terms.

Thus, if the first term of an arithmetical series is 3, the common difference 2, and the number of terms 12, the last term, and the sum of the series, will be found as follows:—

$$11 \times 2 + 3 = 22 + 3 = 25 = \text{last term.}$$

$$\text{And } (3 + 25) \times 6 = 28 \times 6 = 168 = \text{sum of the series.}$$

The last term of a geometrical series may be found by raising the ratio (which may be either an integer or a fraction) to the power denoted by 1 less than the number of terms, and multiplying the number thus found by the first term of the series. And the sum of the series may be found by multiplying the last term by the ratio, and dividing the difference of this product and the first term by the difference between the ratio and unity—observing that in a descending series continued to infinity, the last term = 0. Thus, if a geometrical series contains 6 terms, the first term of which is 7, and the ratio 3, the last term and sum are found as follows:—

$$3^5 \times 7 = 3 \times 3 \times 3 \times 3 \times 3 \times 7 = 243 \times 7 = 1701 = \text{last term.}$$

$$\text{And } \frac{1701 \times 3 - 7}{3 - 1} = \frac{5103 - 7}{2} = 2548 = \text{sum of series.}$$

## PART II.—ARITHMETIC OF QUANTITIES.

THE Arithmetic of Quantities, or Practical Arithmetic, is nothing more than the application of the principles which have been already explained to those qualities, circumstances, or relations of things which determine their value in the commerce of the world.

These qualities, circumstances, and relations upon which the value of things depend, are very numerous; but the principal, if not the whole of them, as used for arithmetical purposes, may be brought under the several kinds of *weight*, *measure*, *time*, and *money*.* The rules most commonly used in the operation and application of quantities, are Reduction, Compound Addition, Compound Subtraction, Compound Multiplication, Compound Division, Compound Proportion and Practice.

---

* *Weights* are all of the same kind, although different in denomination; and if the relation between them be known, a quantity expressed in any one denomination can always be expressed in any other denomination.

*Measure* may differ, not merely in denomination, but absolutely in kind. Simple extension, for instance, is totally different from surface, and cannot, in any way, be compared with, or changed into, it; for the greatest extent of mere length would not make a single inch of surface. Solidity, or capacity, is different from both of the other two, and cannot be converted into them, or they into it; neither can they be compared, so as to say which is the greater and which is the less.

*Time* is a quantity, not only different from all these, but much less easy to understand; in fact, when we come to apply numbers to time, and attempt to say how long or how short it is, the thing that we really estimate is not time, but motion. If we had no contrivance except those quantities themselves, we should never be able to know any thing about the comparative greatness and value of those which were of different kinds. This renders it necessary to introduce another quantity, which shall not belong to any of these kinds, but which may, when necessary, be the representation of them all; this quantity is that which we call *Money*, whether it be composed of a substance which has real value in itself, like silver or gold, or whether its value depend upon the faith or confidence that people have in each other, as is the case with a bank note.—*Complete Governess.*

## 1. *Weight, Measure,*[*] *Time, and Money.*

Weight determines the quantity of matter that is in anything. The standard from which (considered as unit) all measures of weight are to be computed, is the "imperial standard troy pound." This standard, if lost, is to be restored by the following calculation:—if a cubic inch of distilled water be weighed in air by brass weights, at the temperature of 62 degrees of Fahrenheit's thermometer, the barometer being at 30 inches, it is equal to 252·458 grains; and 5760 of such grains are to be a pound weight troy. (5 Geo. IV. c. 74, s. 5.)[†] The proportions of troy and avoirdupois weights, as regulated by the Act last cited, s. 4, are as follows:—one twelfth part of the pound to be an ounce; one-twentieth of such ounce, a pennyweight; one twenty-fourth part of such pennyweight, a grain; so that 5760 such grains is a troy pound, and 7000 such grains a pound avoirdupois; one-sixteenth of the pound avoirdupois is an ounce; and one-sixteenth of such ounce, a dram. And, by 5 and 6 Will. IV., c. 63, s. 11, it is declared, that 14 pounds are 1 stone; 8 stones, 1 hundred weight; and 20 hundred weight, 1 ton. *Specific gravity*[*] is the relative weight or

---

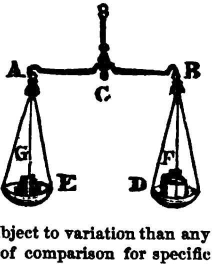
[*] The standard of British weights and measures are now regulated by 5 Geo. IV., c. 74, and 5 and 6 Will. IV., c. 63. Standard weights and measures, verified under the direction of the Treasury, are to be deposited in the office of the chamberlain of the Exchequer at Westminster, and verified copies thereof sent to such place as the Treasury shall direct, and other copies deposited in counties, cities, &c., under the direction of the magistrates. (5 Geo. IV., c. 74, s. 11, 12.) And all copies of such weights and measures verified and stamped at the Exchequer, are deemed legal. (5 and 6 Will. IV., c. 63, s. 4.)

[†] All articles sold by weight are to be sold by avoirdupois, except gold, silver, platina, diamond, and other precious stones, which may be sold by troy weight; and drugs, which, when sold by retail, may be sold by apothecaries' weight. (5 and 6 Will. IV., c. 63, s. 10.) Troy weight is also used for experiments in natural philosophy, and determining the strength of spirits. In apothecaries' weight, the pound weight troy is used; but the ounce is divided into 8 drams, and the dram into 3 scruples; so that the latter is equal to 20 grains. The excise duty on glass, hops, paper, and soap, are charged by avoirdupois weight. For scientific purposes, the grain only is used; and sets of weights are constructed in decimal progression, from 10000 grains downwards to $\frac{1}{100}$ of a grain.

---

By comparing the number of grains in the avoirdupois and troy pound and ounce respectively, it appears that the troy pound is less than the avoirdupois, in the proportion of 14 to 17, nearly; but the troy ounce is greater than the avoirdupois, in the proportion of 79 to 72, nearly. One pound troy is equal to 13oz. 2⅔drs. avoirdupois.

The usual mode of ascertaining the weight or quantity of any substance, is by placing such substance in a balance, or an authorized measure, and comparing it with a given standard. But, under the excise laws, as it would frequently be inconvenient, if not impossible, to submit the articles to these tests, the weights or measures are determined by various summary admeasurements, amounting, in some cases, only to an approximation to the true quantities; but which are, nevertheless, sanctioned by law; and the quantities so ascertained are made a charge upon the traders. These summary admeasurements are called "guaging," and will be fully described in subsequent chapters. In cases where the amount of duties are chargeable by actual weight, the excise traders are required to keep just scales and weights for the use of the officers; and penalties are imposed upon traders using unjust scales or weights, or using any contrivance so as to impede the officer in taking a true account. (10 Geo. III., c. 44, s. 1, 2; 26 Geo. III., c. 77, s. 8; 28 Geo. III., c. 37, s. 15, &c.) The characteristics of a good balance are three: 1st. The *beam* (A B) should rest in an horizontal position when the scales (E D) are either empty or loaded with equal weights. 2nd. A very small addition of weight put into either scale, should cause the beam to deviate from the level. 3rd. The beam, when deflected, should have a tendency to restore itself. And the best mode of testing the accuracy of the balance, is to change the weight from one scale to the other.

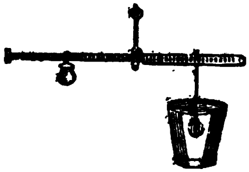


[*] Rain water, in consequence of being less subject to variation than any other body, has been taken as the standard of comparison for specific gravities; and, by a fortunate coincidence, it happens, that a cubic foot of rain water weighs exactly 1000 ounces avoirdupois, if its heat be 60 degrees by Fahrenheit's thermometer. When its temperature is raised to 100 degrees, however, it increases its volume to $\frac{1}{167}$ of its bulk. Water, therefore, at the heat of 60 degrees, has been called 1000; and it is indifferently expressed 1000, or decimally, 1·000. And when we speak of the specific gravity of any other body, we express it in figures which show how many times 1000 ounces of such body a cubic foot contains. If more

gravity of any body or substance considered with regard to some other body, (water, for instance,) which is assumed as a standard of comparison.

---

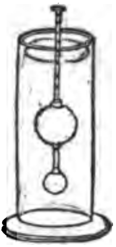
than 1000, we see that it is heavier than water; if less, that it is lighter than water. All bodies weigh in proportion to their particles of gravitating materials. Gold, for instance, is more minute, simple, and cohesive than any other body; and we say that its specific gravity is upwards of 19; the meaning of which is, that a given cubic foot of gold will weigh 19 times as much as the water that could be contained in a vessel the capacity of which is equal to one cubic foot. In this manner, if the same substance be weighed in two different fluids, the weight which it loses in each will be the specific gravity of the fluid. And as a solid, when weighed in water, *loses* of its weight a quantity precisely equal to the weight of its own bulk of water, the specific gravity of any such solid may be found by the following rule:—Divide the weight found on weighing the article in air by the loss of weight in water; the quotient is the specific gravity. Thus, if a portion of glass weighs 2387·8 grains in air, and 1405·6 grains in water, and the total weight be divided by the loss, which is 982·2, the quotient or specific gravity of that glass will be 2·431. If the solid be so light as to float upon water, it is convenient to attach to it a heavier body, sufficient to cause it to sink, but the weight of which, in water, must be added, in computing the loss. The specific gravity of *fluids* is ascertained by weighing a known body immersed in them; for the loss by immersion will show the weight of the same bulk of the fluid; and, consequently, the proportion of these several quantities to the loss the same solid sustained in water, (being reduced, as in the other case, to the standard of unity,) will exhibit the specific gravity. Various modes have been devised for ascertaining specific gravities, upon the principle that bodies immersed in a fluid meet with a resistance proportioned to the specific gravity of such fluid. One of these is the *Hydrostatic Balance*, which differs from a common balance chiefly by having a small hook under its scale, from which hook is suspended, by means of a horse hair, or thread of silk, &c., the different bodies to be tried, so that they may be immersed in water without wetting the scale. A species of steelyard balance is sometimes employed for this purpose, as represented in the margin.



Another such instrument is the *Hydrometer*, (from ὕδωρ, "water," and μέτρον, a "measure,") which is a test of the density or gravity of water, and is merely a ready substitute for the hydrostatic balance, to which it is preferred, on account of the ease and expedition with which it can be used, so as to ascertain the quantity of spirits or alcohol, whether pure or mixed with water. For this reason it has been adopted by

*Measure* is of three distinct kinds. 1st. Simple extension, or *lineal* measure. 2. Surface, or *superficial*, usually called "Square Measure." 3. Solidity, or *capacity*, usually called "Cubic, or Solid Measure." The standard from which, (considered as unit,) all measures of extent, whether lineal or superficial, are to be computed, is the "imperial standard yard," which, if lost, is to be restored by a pendulum vibrating seconds at London in the proportion of 36 to 39·1398. (5 Geo. IV., c. 74,

---



government to ascertain the strength of spirituous liquors. The specific gravity of proof spirits is ascertained to be 923, at the heat of 51°; and the relation which all other spirits has to this standard or proof, is expressed by saying that they are so much *over* or *under* proof; so when it is said that a spirit is 25 per cent. over proof, it implies that 100 gallons of it will admit of 25 gallons of water to reduce it to the strength of proof; and if it be 25 per cent. under proof, it is considered to contain 25 gallons of water more than is contained in 100 gallons of proof spirits. This instrument consists of a copper ball with a stem, on which is marked a scale of equal parts, or degrees. The point to which the stem sinks in water being ascertained and marked on the scale, we can tell how many degrees any other liquid is heavier or lighter, by observing the point to which the stem sinks it. It is used in conjunction with the thermometer, in order that proper allowance may be made for the expansion or condensation caused by the temperature.

The *Saccharometer*, as its name imports, is a measure of sweetness or saccharine matter. The one now used in the Excise in England, is BATES's saccharometer, (6 Geo. IV., c. 80, and General Order,) which is about 7½in. long, consisting of an elliptical ball, or float, with a flat graduated stem of 4¼in. in length, having a small loop at the bottom. This instrument may be said to be an hydrometer, calculated to show the specific gravity of *wash*, instead of spirits; for, as spirituous liquors are strong in proportion to their levity, or weak in proportion to their gravity, and as the hydrometer will sink deeper in *strong*, than in weak, spirits, so the saccharometer will sink deeper in *weak*, than in strong, worts. When, therefore, a wort is said to be 60lbs. or 60 degrees gravity, the meaning is, that 36 gallons of such liquid weighs its weight of water and 60lbs. more; so that, among distillers and brewers, by degrees of gravity is meant the excess of the weight of worts above that of an equal bulk of water in 1000 parts of the latter. Hence, the heavier the malt infusion, or *worts*, as it is termed, the

s. 3.) The proportions of *lineal* measure,* as regulated by the Act just cited, s. 1, are as follows:—one-third part of the standard yard to be a foot, and the twelfth part of a foot, an inch; the pole, or perch, to contain five and a half yards; the furlong, two hundred and twenty yards; and the mile, one thousand seven hundred and sixty yards. The proportions of *superficial* measure declared by the same Act, s. 2, are as follows:—the rood of land is 1210 square yards; and the acre, 4840 square yards, being 160 square perches, poles, or rods. The standard from which, (considered as unit,) all measure of *capacity*, as well for liquid as for dry goods, are to be computed, is the "imperial standard gallon,"† containing 10lbs. weight avoir-

---

greater the value, since it holds in solution a greater quantity of saccharine matter. Tables and instructions always accompany these instruments; and a little practice renders them easy of application.

* The Scotch ell, and all local or customary measures, are abolished as standards. (5 and 6 Will. IV., c. 63.) An inch is the smallest lineal measure to which a name is given; but subdivisions are used for many purposes. Among mechanics, the inch is commonly divided into *eighths*; by the officers of the revenue, and by scientific persons, it is divided into *tenths*, *hundredths*, *&c.* For measuring long distances, surveyors use *Gunter's chain*, or the *Perambulator*. For measuring lengths, breadths, and depths in guages, &c., rules, rods, and measuring tapes are used, as explained in the proper places. The *dimensions* of bodies are taken by lineal measure; but their *contents* are calculated by cubic measure. The excise duties on post horses are partly charged according to lineal measure, or distance.

† The 6 Geo. IV., c. 58, s. 6, directs, that in "all acts relating to the Excise, whenever and for whatever purpose any gallon is mentioned, it shall be deemed a gallon, imperial standard gallon measure; and whenever any other measure by name is mentioned, it shall be deemed to be a measure formed of the usual number of gallons, each such gallon being imperial standard gallon measure; and all duties, allowances, drawbacks, payments, accounts, and reckonings of or relating thereto, under any law of excise, shall be made and kept according to such imperial standard gallon measure only, or some multiple, part, or proportion thereof. (See, also, 5 Geo. IV., c. 74; 6 Geo. IV., c. 12; 5 and 6 Will. IV., c. 63.) By the imperial gallon the excise duties are charged on spirits and vinegar; and on malt they are charged by the imperial bushel. The Winchester bushel, and all local or customary measures,

dupois of distilled water, weighed in air, at a temperature of 62 degrees of Fahrenheit's thermometer, the barometer being at 30 inches (5 Geo. 4., c. 74, s. 6); consequently the pint will hold 1¼lbs.; and the bushel, 80lbs. The proportions of the measure of *capacity*, as regulated by the section last cited, are as follows:—the quart to be the fourth part of the standard gallon; the pint, the eighth part of such gallon; two gallons, one peck; eight gallons, one bushel; and eight bushels, one quarter.

*Time* is the measure of motion and the succession of thoughts; and *money*, the portable standard equivalent for commodities, labour, and value transferred.

For the purpose of saving time in calculations, these various matters are reduced to tables, the mode of making which will be shown in the subsequent sections, and the tables themselves will be given at the end of the chapter.

### 2. *Reduction.*

REDUCTION is the conversion of numbers from one denomination to another, but still retaining the same value.

*To reduce from a greater denomination to a less one.*

RULE.—Consider how many of the less denomination

---

are abolished. Heaped measures are also abolished; but such articles as have heretofore been sold by that measure, and are incapable of being stricken, may be sold by a bushel containing 80lbs. avoirdupois of water, with a round, plain, and even bottom, and being 19½ inches from outside to outside, or by any multiple or aliquot part thereof, filled in all parts as nearly to the level of the brim as the articles will admit. (5 Geo. IV., c. 74, s. 7; 5 and 6 Will. IV., c. 63, s. 7, 8.) Several denominations of measure have been adopted for liquids; but many of them may be considered rather as the names of the casks or vessels in which the commodities are imported, than as expressing any definite number of gallons. It is now the practice to guage all such vessels, and charge them according to the actual quantity found therein.

Square Measure, Cubic or Solid Measure, and the Measure of Capacity, being those with which the practical officer is chiefly concerned, ought to be firmly fixed on the memory.

make one of the greater, and by that number multiply the given number; the product will be the answer.*

---

* EXAMPLES IN REDUCTION.

(1.) Reduce £1 sterling to farthings.

£1<br>
20<br>
20 shillings.<br>
12<br>
240 pence.<br>
4<br>
Ans. 960 farthings.

(3.) Reduce 1 bushel to solid inches.

277·274 × 8 = 2218·192. Ans.

(5.) In 1 ton how many ounces?

1 ton.<br>
20<br>
20 cwt.<br>
4<br>
80 qrs.<br>
28<br>
2240 lbs.<br>
16<br>
Ans. 35840 oz.

(2.) Change 960 farthings into their highest denomination.

4 ) 960 farthings.<br>
12 ) 240 pence.<br>
20 ) 20 shillings.<br>
Ans. 1 pound.

(4.) Change 2218·192 solid inches to their highest denomination in imperial measure.

2218·192 ÷ 277·274 = 8 galls.<br>
And 8 ÷ 8 = 1 bushel.

(6.) In 35840 oz. how many tons?

16 { 4 ) 35840 oz.<br>
16 { 4 ) 8960<br>
28 { 4 ) 2240 lbs.<br>
28 { 7 ) 560<br>
4 ) 80 qrs.<br>
20 ) 20 cwt.<br>
Ans. 1 ton.

(7.) Reduce 337587 farthings to pounds.

(9.) Reduce 6 cwt. 1 qr. 18 lbs. to ounces.

(11.) Reduce 16 bushels, 3 pecks, 1 gallon, to gallons.

(13.) Reduce 1 ton of wine to pints.

(15.) Reduce 36470 minutes to days.

(8.) In £351 13s. 0¾d., how many farthings?

(10.) In 11488 oz., how many cwt.?

(12.) In 135 gallons how many bushels?

(14.) In 2016 pints how many tons?

(16.) Reduce 25 days, 7 hours, 50 minutes, to minutes.

By applying these rules to the standards and regulations respecting weights, measures, &c., (see the preceding section,) Tables are constructed showing the relative value of the different denominations, and of any given number of other denominations; of which the most useful will be found at the end of the present chapter. Thus, the Table of Sterling Money is merely a continuation or extension of the above calculation, example 1. Measure of Capacity is founded upon such calculations as in example 3; Avoirdupois Weight, upon such calculations as in example

*To reduce from a less denominator to a greater one.*

RULE.—Divide the given number by as many of the

---

5; and the other Tables of Weights, Measures, &c., are founded on similar principles.

When, in Reduction descending, there are compound numbers, they must be added or taken into the same denominations as the calculations proceed. And when, in Reduction descending, there are remainders after dividing, they will have the same denominations as their respective dividends, and, in the answer, must be brought down and considered accordingly. When there are denominations between the proposed and required ones, it is frequently the best to reduce the proposed to the next less or greater denomination, and this to a next less or greater again, and so on, until it be reduced to the denomination required, as in the foregoing examples. But when the extreme denominators are known, and can be conveniently multiplied or divided, the calculation will be shortened by using them.

When the extreme denominator is such a sum as cannot be conveniently used as a divisor, the proper result may frequently be obtained by Multiplication, instead of Division, by the use of what is technically called a *factor*, which, as its application is very common in excise calculations, it may be proper to explain in this place.

TO FIND A FACTOR.

A factor may be found by the Rule of Three, as follows:—*As the given divisor is to unity, so is unity to the factor sought.* In other words, if 1, with a sufficient number of decimal ciphers, be divided by the given divisor, a sum will be obtained which, when used as a multiplier, will produce the same results as dividing by such given divisor: thus, a bushel contains 2218·192 solid inches; and a gallon, 277·274 solid inches; which sums, or numbers of inches, are, therefore, the proper divisors for reducing solid inches to bushels and gallons respectively (see example 3, page 30); but as these divisors are large and inconvenient, it is desirable to obtain factors which may be used instead of them; we therefore divide unity by them as follows:—

| | |
|---|---|
| 2218·192 ) 1·000000000 ( ·000451 | 277·274 ) 1·000000000 ( ·003607 |
| 8872768 | 831822 |
| 11272320 | 1681780 |
| 11090960 | 1663644 |
| 1813600 | 1813600 |
| 2218192 | 1940918 |

The quotients are the factors for reducing solid inches to bushels and gallons respectively; and, in the same way, factors may be obtained for reducing inches into pounds' weight of various commodities, as well as for money, &c., of which factors proper Tables are inserted in a subsequent part of this work. To show that these factors will produce the same result as if the divisors were used, an example in each case may be selected.

less denomination as make one of the greater; the quotient will be the answer.

---

(17.) In 800,000 inches how many bushels?

By Division.

```
2218·192 ) 800000·000 ( 360·6 bushels.
           6654576
           --------
           13454240
           13309152
           --------  By Multiplication.
            14508800     ·000451
            13309152          800000
            --------     ------------
             1199648     360·8 bushels.
            --------     ----
```

(18.) In 80,000 inches how many gallons?

By Division.

```
277·274 ( 80000·0000 ( 288·5 gallons.
          554548
          -------
          2454520
          2213192
          -------  By Multiplicatn.
           2363280      ·003607
           2218192         80000
           -------     ----------
           1450880 gals. 288·560000
           1386370     ----------
           -------
```

In excise calculations it is frequently necessary to reduce compound numbers to decimals, and decimals to compound numbers. The rules for effecting these purposes are as follow:—

### TO REDUCE NUMBERS OF DIFFERENT DENOMINATIONS TO A DECIMAL.

RULE.—Reduce the given numbers to the lowest denomination for a numerator, and reduce the denominator to the same, then annex ciphers, and divide the one by the other; or begin at the lowest, and reduce them in their order.

### TO REDUCE A DECIMAL TO ITS PROPER DENOMINATION.

RULE.—Multiply the decimal by the value of the next lower denomination, and point off as many places in the left hand as there are places in the decimals; then multiply the figures pointed off by the value of the next lower denominator, pointing off as before; and proceed in this manner through all the denominations to the last, when the several figures standing on the left of the decimal point will be the answer required.

(19.) Reduce 15s. 6¾d. to the decimal of a pound.

```
 20   15s. 6¾d.          4 ) 3·00
 12   12                     ----
---   --                12 ) 6·7500
240   186        or,         ------
  4     4               20 ) 15·56250
---   ---                    --------
960 ) 747·0 ( ·778125   Ans.  ·778125
                              -------
```

(20.) What is the value of ·778125 of a pound?

```
              ·778125
                   20
              --------
             15·562500
                   12
              --------
              6·750000
                     4
              --------
Ans. 15s. 6¾d. 3·000000
              --------
```

(21.) Reduce 3s. 9d. to the decimal of a pound.

(22. What is the value of ·1875 of a pound?

(23.) Reduce 1½d. to the decimal of a shilling.

(24.) What is the value of ·125 of a shilling?

(25.) Reduce 3 bushels, 1 peck to the decimal of a quarter.

(26.) What is the value of ·40625 of a quarter?

(27.) Reduce 6¾ inches to the decimal of a foot.

(28.) What is the value of ·5625 of a foot.

### 3. *Compound Addition.*

COMPOUND ADDITION is the method of collecting several nnmbers of different denominations into one sum.

RULE.—Place all numbers of the same denomination directly under one another; add the figures in the lowest denominations, and find how many of the next higher denomination that sum contains; write down the remainder, if any, at the foot of the column, and carry 1, for each of the higher denomination, to the next column; proceed in this manner through all the denominations, till you come to the highest, the sum of which, together with the several remainders, will give the answer required.

PROOF.—As in Simple Addition.*

---

By the foregoing rule, (that is, dividing or multiplying by as many of the less as make one of the greater denominator,) we can reduce a decimal of one denomination to the decimal of another denomination.

| (29.) Reduce ·45 of a shilling to the decimal of a pound. | (30.) Reduce ·0225 of a pound to the decimal of a shilling. |
|---|---|
| 20 ) ·45 | ·0225 |
| | 20 |
| ·0225 Ans. | ·4500 Ans. |

The Decimal Tables given at the end of the present chapter, are constructed according to the foregoing rules and examples.

* EXAMPLES IN COMPOUND ADDITION.

| (1,) | | | (2.) | | | (3.) | | |
|---|---|---|---|---|---|---|---|---|
| £ | s. | d. | gal. | qts. | pts. | bush. | gal. | pts. |
| 346 | 12 | 3 | 792 | 3 | 1 | 542 | 1 | 3 |
| 182 | 17 | 2 | 134 | 2 | 0 | 473 | 0 | 1 |
| 701 | 5 | 1 | 432 | 1 | 1 | 476 | 4 | 3 |
| 510 | 14 | 3 | 368 | 3 | 1 | 341 | 0 | 2 |
| 156 | 3 | 2 | 549 | 2 | 0 | 143 | 1 | 1 |
| 642 | 11 | 1 | 714 | 3 | 1 | 684 | 1 | 1 |
| 2540 | 3 | 0 | 2993 | 0 | 0 | 2659 | 0 | 4 |

(4.) The malt duty charged in the year ending October 10th, 1834, was as follows:—In England, £4,334,797 5s. 11d.; in Scotland, £545,561 14s. 5d.; and in Ireland, £268,896 3s. 8d.; what was the total amount? Ans. £5,149,255 4s.

When the lower denominations can be easily reduced to decimals, (see page 32, and the Decimal Tables, *infra*,) the quantities may be added as

## 4. *Compound Subtraction.*

COMPOUND SUBTRACTION is the method of taking a less compound number from a greater.

RULE.—Place the less number under the greater, so that the numbers of the same denomination may stand directly under each other; begin at the right hand, and subtract the number of each denomination in the lower line from the number above it, and set the remainder under it; but if the lower number of any denomination is greater than the upper, add as many to the upper as make one of the next higher denomination, and after subtracting the lower from that sum, add 1 to the lower number of the next denomination before you subtract it; proceed in this manner till the whole is finished.

PROOF.—As in Simple Subtraction.*

---

in Addition of Decimals, (see page 15,) and the decimal in the total reduced to its proper denomination, if necessary, as in page 32.

(5.) Add £35 15s. to £78 2s. 6d.

(15s. = £·75) £35·75
(2s. 6d. = £·125, see page 32.) 78·125

Ans. £113 17s. 6d. 113·875 = 17s. 6d. (See page 32.)

* EXAMPLES IN COMPOUND SUBTRACTION.

| | (1.) | | | (2.) | | | (3.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | £. | s. | d. | bush. | pks. | gal. | qrs. | bush. | pks. |
| From | 6 | 14 | 6 | 9864 | 3 | 0 | 7498 | 2 | 2 |
| Take | 4 | 15 | 8 | 1986 | 3 | 1 | 5969 | 7 | 3 |
| Rem. | 1 | 18 | 10 | 7877 | 3 | 1 | 1528 | 2 | 3 |

(4.) The excise duties for 1834 amounted to £13,946,348 5s. 7¾d.; and for 1835, to £11,681,197 17s. 8½d.; what was the difference? Ans. £2,265,150 7s. 11¼d, decrease.

When the lower denomination can be easily reduced to a decimal, (see page 32, and the Decimal Tables, *infra*,) the quantities may be subtracted as in Subtraction of Decimals, (page 15,) and the decimal in the difference, if any, reduced to its proper denomination, as in page 32.

(5.) Take £9 17s. 6d. from £84 2s. 6d.

(2s. 6d. = £·125) £84·125
(17s. 6d. = £·875) 9·875

Ans. £74 5s. £74·250 = 5s.

## 5. *Compound Multiplication.*

COMPOUND MULTIPLICATION is the method of multiplying sums or quantities which consist of different denominations.

RULE.—Multiply the number in the lowest denomination by the multiplier, and find how many units of the next denomination are contained in the product, setting down what remains; multiply the next denomination in the same manner, adding to the product the units before found, and find how many units of the next denomination are in the amount, which set down, and carry as before; proceed thus to the whole numbers, which multiply, as in Simple Multiplication, and the product, with the several remainders, will be the answer.*

---

* EXAMPLES IN COMPOUND MULTIPLICATION.

| | (1.) | | | (2.) | | | (3.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | gals. | qts. | pts. | bush. | gals. | pts. |
| Multiply | 0 | 2 | 7 | 74 | 3 | 1 | 404 | 1 | 3 |
| By | | | 11 | | | 8 | | | 9 |
| | 1 | 8 | 5 | 599 | 0 | 0 | 3637 | 4 | 3 |

If the multiplier exceeds 12, and is the product of two or more numbers, neither of which exceeds 12, it may be multiplied successively by the two numbers which make such product.

(4.) What is the duty on 63 gallons of spirits, at 7s. 6d. per gallon ?

| | | | |
|---|---|---|---|
| | | 7s. | 6d. |
| (7 × 9 = 63) | | | 7 |
| | 2 | 12 | 6 |
| | | | 9 |
| Ans. | 23 | 12 | 6 |

If the multiplier is not the product of any two or more numbers, it may be multiplied by two such numbers as come nearest the given multiplier, and this product may be added to the product of the first multiplicand when multiplied by the difference.

(5.) What is the duty on 93 cwt. of hops, at 18s. 8d. per cwt.?

| | | | |
|---|---|---|---|
| (93=10×9+3) | 0 | 18 | 8 × 3 |
| | | | 10 |
| Duty on 10 cwt. | 9 | 6 | 8 |
| | | | 9 |
| Duty on 90 cwt. | 84 | 0 | 0 |
| Duty on 3 cwt. | 2 | 16 | 0 (× 3) |
| Duty on 93 cwt. | 86 | 16 | 0 Ans. |

**Proof.**—As in Simple Multiplication.

### 6. *Compound Division.*

**Compound Division** is the method of dividing numbers of several denominations into equal parts.

**Rule.**—Begin at the highest denomination of the dividend, and divide as in Simple Division; reduce the remainder, if any, to the next lower denomination, adding the given number of that name; divide this sum, and proceed in the same manner with all the denominations: the several parts of the quotient thus found will be the answer required.

**Proof.**—By Multiplication.*

---

Questions of this description are usually worked by rules of Practice. (See Practice, *infra.*)

When the lower denominations can be conveniently reduced to a decimal, (see page 32, and the Decimal Tables, *infra,*) the answers may be found more readily, especially when the quantities are large.

(6.) Multiply 484 by £50 15s.

| | |
|---|---|
| (15s. = £·75) | 50·75 |
| | 484 |
| | 20300 |
| | 40600 |
| | 20300 |
| Ans. | £24563·00 |

(7.) (Multiply 58½ gallons by 17000.

| | |
|---|---|
| (½ = ·5) | 58·5 |
| | 17000 |
| | 4095000 |
| | 585 |
| Ans. | 994500·0 |

* EXAMPLES IN COMPOUND DIVISION.

Divide (1.) £1 8s. 5d. by 11; (2.) 598 gals. 2 qts. by 8; (3.) 3637 bush. 4 gals. 3 pts. by 9.

| | £ | s. | d. |
|---|---|---|---|
| 11 ) | 1 | 8 | 5 |
| | 0 | 2 | 7 |

| | gals. | qts. | pts. |
|---|---|---|---|
| 8 ) | 598 | 2 | 0 |
| | 74 | 3 | 1 |

| | bush. | gals. | pts. |
|---|---|---|---|
| 9 ) | 3637 | 4 | 3 |
| | 404 | 1 | 3 |

If the divisor exceeds 12, any two numbers which, multiplied together, will produce such divisor, may be used consecutively.

(4.) What is the rate of duty of a gallon of spirits, if 63 gallons be charged £23 12s. 6d.?

(7 × 9 = 63)

| | £ | s. | d. | |
|---|---|---|---|---|
| 9 ) | 23 | 12 | 6 | |
| 7 ) | 2 | 12 | 6 | |
| | | 7 | 6 | Ans. |

## 7. *Compound Proportion.*

COMPOUND PROPORTION is usually defined to be the method of finding quantities that require two or more statings in simple proportion; but it is here designed to

---

If the divisor cannot be produced by the multiplication of small numbers, the operation must be performed nearly the same, as in Long Division of Simple Numbers; the remainder, if any, being reduced into the next lower denomination; and after taking in any of the same name in the dividend, again divided by the divisor; and the remainder, if any, again reduced to the next lower denomination, and again divided, and so on, through all the denominations, to the last.

(5. Divide £59 5s. 11d. by 19.

```
       £  s.  d.   £  s. d.
  19 ) 59  5  11 ( 3  2  5. Ans.
       57
       —
        2
       20
       —
  19 ) 45 ( 2
       38
       —
        7
       12
       —
  19 ) 95 ( 5
       95
       —
```

When the lower denominations can be conveniently reduced to a decimal, (see page 32, and the Decimal Tables, *infra*,) the answers may be found more readily, especially when the quantities are large, thus:

(6.) Divide 24563 by £50 15s.

```
           50·75 ) 24563·00 ( 484 Ans.
(15=£·75)          20300
                   -----
                    42630
                    40600
                    -----
                     20300
                     20300
                     -----
```

(7.) Divide 99450 by 58½ gallons.

```
         58·5 ) 99450·0 ( 1700 Ans.
(½ = ·5)        585
                ----
                4095
                4095
                ----
                  00
                ----
```

As, when the numbers are large, it is much more convenient in practice to multiply than to divide, it is common, in excise calculations, to substitute the former operation for the latter, which is done by using what is technically called a *factor*. (See page 31.)

* Proportion is so universal in its application,—at least among all substances, and qualities of substances, which can in any way be measured, weighed, or valued, so as to be expressible in numbers,—that its importance cannot be too forcibly impressed on the learner. In its various applications, it is the most useful in the whole business of education; and that, not so much on account of its merely arithmetical and geometrical applications, as because, being founded upon the doctrine of cause and effect, no one can think or reason accurately upon any one subject without it. The rule of Proportion of Simple Numbers has been already given, as well as the rules for Arithmetical and Geometrical Progressions (pp. 9 and 22). These being fully understood, the chief difficulty in apply-

include any kind of proportion, whether single or double, in which the terms of the question include different denominations.

---

ing the subject to proportion and progression of quantities, of different denominations, is, as to the manner in which the various questions are to be stated for working. To obviate this difficulty as far as practicable, consistently with the limits and objects of the present Treatise, a few of the leading subjects to which Arithmetical Proportion is usually applied in excise calculations are selected, the examples being, in each case, preceded by the proposition or mode of stating the question.

PRICES, DUTIES, SALARIES, AND INTEREST.

One of the most simple and useful applications of Proportion, is where two quantities of the same kind of goods, and the price and value of one of them, are given, to find the price or value of the other. In excise matters, this is more particularly applied to the calculation of duties.

PROPOSITION.—As the quantity of which the price or duty is known, is to the known price or duty, so is the quantity of which the price or duty is sought, to the price or duty required.

EXAMPLES IN COMPOUND PROPORTION.

(1.) If the duty on glazed paper be 2¼d. per pound, what is that per cwt., or 112 lbs.?

Having stated the three terms by the general rule, the middle term is reduced to farthings; the second and third terms are multiplied together, and give the answer in farthings, because the first term being 1, does not require to be used as a divisor. The answer is divided by 4 and 12, to reduce it to shillings.

If 1lb. : 2¼d. : : 112 lbs.
4
9
112
4 ) 1008
12 ) 252
Ans. 21s., or £1 1s. per cwt.

(2.) If the duty on the excess of fluxed materials for flint glass be 2d. per lb, what is that per cwt.?

If 1 lb. : 2d. : : 112 lbs. : 18s. 8d. Ans.

(3.) If the duty on fluxed materials for flint glass be 6s. 8d. per 100 lbs., what is that per lb.?

If 100 lbs. : 6s. 8d. : : 1
12
80
4
100 ) 320
Ans. 0¾d.·2 3·2

In the foregoing questions, as well as in any other where one of the given terms is unity, the formality of stating the question may be dispensed with, and the answer obtained by Compound Multiplication or Compound Division, and sometimes more readily by Practice, (which see.)

RULE.—1st. State the question ; that is to say, place the given numbers so that the first and third may be terms of supposition and demand, and the second the same kind or denomination as the answer required.

---

(4.) If the auction duty on an estate in Ireland, which sold for £200, be £5, what will be the duty on an estate which sells for £410 10s.?

If £200 : £5 : : £410 10s.
20 20
4000 8210
5
4|000 ) 41|050
Ans. £10 5s. 3d. 10·2625

(5.) If the duty on 19 bushels of malt be £2 9s. 1d., what will be the duty on 5976 bushels ?

(6.) What will be the duty on 19 bushels of malt, when 5976 bushels are charged £771 18s.?

(7.) If £23 12s. 6d. be the duty on 63 galls. of spirits, for how many gallons should £204 15s. be paid ?

(8.) When the duty on 546 galls. of spirits is £204 15s., what is the duty on 63 gallons ?

(9.) What is the amount of an officiator's salary for 66 days, at £50 per annum ?

If 365 days : £50 : : 66 days : £9 0s. 9¾d. Ans.

This and similar questions of common occurrence, may frequently be solved more readily by finding the decimal for a single day or a single article, and multiplying such decimal by the number of days or articles. In the question last stated, the decimal for a single day is found and used as follows :—

days. £. day. £.
If 365 : 50 : : 1 : ·1369863 for a day.
Number of days 66
8219178
8219178
9·0410958

which, reduced to its proper value, gives £9 0s. 9¾d., as above.

For a leap year, the decimal for a single day will be slightly varied, thus :

If 366 days : £50 : : 1 day : ·136612.

(See the Tables of Factors for Salaries, and for calculating Days, &c., *infra.*)

(10.) What is the interest of £547 15s. for 3 years, at £5 per cent. per annum ?

As £100 : £5 : : £547·75 (15s. = ·75. See page 15.)
Or, 20 : 1 : : £547·75 : £27·3875 Interest for a year.
3
82·1625

which, reduced to its proper value, (see page 32,) gives £82 3s. 3d., the interest for 3 years.

The foregoing examples will show the manner in which decimals may be advantageously used in this rule. (See the Tables of Decimals, &c., *infra.*)

2nd. Bring the first and third numbers into the same denomination, and the second into the denomination most convenient for working.

---

### SPECIFIC GRAVITY, &c.

Another application of the Rule of Three is in determining the specific gravities, weights, and magnitudes of different bodies; each of these qualities, as shown in page 25, bearing certain relations or proportions to the others.

*To determine the Specific Gravity of a Solid, on its being weighed in and out of Water.*

Prop.—As the lost weight in, is to the weight out, so is the specific gravity of, water, to that of the body.

(11.) What is the specific gravity of a quantity of glass weighing 2387·8 grains in air, and 1405·6 grains in water?

2387·8 — 1405·6 = 982·2.

As 982·2 (lost weight) : 2387·8 (weight) : : 1000 (water) : 2431. Ans.

This is, in effect, the same as the rule and example in page 26.

*To find the Magnitude of a Body from its Weight.*

Prop.—As the specific gravity of the body (see the Table, *infra*) is to its weight in avoirdupois ounces, so is one cubic foot, or 1728 cubic inches, to its magnitude in feet or inches respectively.

(12.) An empty cask, made of dry oak, weighs 46 lbs. 10 oz.; required the contents of the materials in cubic inches.

46 lbs. 10 oz. = 746 oz.

As 925 (sp. grav.) : 746 (weight) : : 1728 in. : 1393·5 cubic in. Ans.

(13.) A quantity of vinegar weighs 84 lbs. avoirdupois, what is its content in cubic inches?

84 × 16 = 1344.

As 1010 (sp. grav.) : 1344 (weight) : : 1728 in. : 2299·4 cubic in. Ans.

(14.) A quantity of proof spirits, at the temperature of 51 degrees, weighs 93 lbs. avoirdupois, what is its contents, deducting 22 lbs. for the weight of the cask?

(93 — 22) × 16 = 71 × 16 = 1136 oz. of proof spirits.

As 923 (sp. grav.) : 1136 (weight) : : 1728 in. : 2127 cubic in. Ans.

*To find the Weight of a Body from its Magnitude.*

Prop.—As 1 cubic foot, or 1728 cubic inches, is to the content of the body, so is its specific gravity (see the Table, *infra*,) to the weight of the body.

(15.) What is the weight of 100 gallons of proof spirits?

100 × 277·274 = 27727·4.

As 1728 in. : 27727·4 in. : : 923 (sp. grav.) : 14810 ounces. Ans.

(16.) What is the weight of 73 gallons of port wine?

As 1728 in. : 73×277·274 in. : : 997 (sp. grav.) : 11678 oz. Ans.

3rd. Multiply the second and third numbers together, and divide the product by the first number; the quotient will be the answer, in the same denomination as

---

### AVERAGING AND COMPOUNDING SPIRITS, &c.

Compound Proportion is likewise applicable to what, in commercial arithmetic, is called, "Alligation," or the compounding and averaging simples of different strengths or qualities. In excise matters, this is chiefly confined to the mixing and reduction of spirits with other spirits or with water. The questions which are most likely to occur in practice, may be stated according to one or other of the following rules; it being recollected, that the strength of proof spirits is 100 degrees, and that the strength of all other spirits is calculated according to the number of degrees or equal parts of 100, or proof, which are contained therein. (See page 27, *ante.*)

*To find the Strength or Value of a Compound, the Rates and Quantities of the Ingredients being given.*

**Prop.**—As the whole composition is to its total value, (each quantity being multiplied by its price or strength,) so is any part of the composition to the mean price or strength of that part.

(17.) 25 gallons of spirits, at 16 per cent. under proof, are mixed with 15 gallons of proof spirits; what strength will the compound be?

| Quan. | | Strength. | | Product. |
|---|---|---|---|---|
| 25 | × | 84 | = | 2100 |
| 15 | × | 100 | = | 1500 |
| 40 | | | | 3600 |

As 40 : 3600 : : 1 : 90 degrees.

And (see page 27) 100 — 90 = 10 deg., or 10 per cent. under proof. Ans.

(18.) 53 gallons of spirits, at 10s. per gallon, being mixed with 10 gallons of water, what is the value of a gallon of the mixture?

| Quan. | | Price. | | Product. |
|---|---|---|---|---|
| 53 | × | 10 | = | 530 |
| 10 | × | 0 | = | 0 |
| 63 | | | | 530 |

As 63 : 530 : : 1 : 8s. 4¾d. Ans.

*To find the Value of Spirits according to the Strength; and to find the Strength according to the Value.*

**Prop.**—As the given strength is to the price, so is any other strength to the price required at that strength; and *vice versa.*

(19.) Spirits at proof are worth 32 shillings per gallon, what would be their value at 25 per cent. over proof?

As 100 (proof) : 32s. : : 125 (25 over proof) : 40s. Ans.

that in which the middle number was left, and may be changed into any other denomination required, as in Reduction.

---

(20.) Spirits at 25 per cent. over proof are worth 20s. per gallon, what would be their value at 10 per cent. under proof?

As 125 (25 over proof) : 20s. : : 90 (10 under proof) : 14s. 4¾d. Ans.

(21.) Spirits at 25 per cent. over proof are worth 40s. per gallon, what strength ought they to be at 32s. per gallon?

As 40s. : 125 (25 over proof) : : 32s. : 100 (proof.) Ans.

### *To find the relative Quantity of Spirits and Water in a Compound of a given Value.*

PROP.—As the given value of the spirits is to the whole mass, so is the value of the mixture to a quantity which, deducted from the whole mass, will leave the quantity of water.

(22.) Spirits, at 10s. per gallon, are mixed with water in such proportion that the mixture is worth 8s. per gallon; what quantity of each is in 63 gallons of the mixture?

As 10 : 63 : : 8 : 50·4 Quantity of spirits.
63 Total quantity.
12·6 Quantity of water.

### *To find the Quantity of Water necessary for reducing Spirits to a given Value.*

PROP.—As the value of the reduced mixture is to the quantity, so is the price of the spirits to the whole reduced mixture; from which, if the spirits be deducted, it will leave the quantity of water required.

(23.) 53 gallons of spirits, at 10s. per gallon, are required to be reduced until they are worth 8s.; what quantity of water is necessary for that purpose?

As 8 : 53 : : 10 : 66¼ Total quantity.
53 Spirits.
Ans. 13¼ Water.

### *To reduce Spirits from any given Strength to Proof.*

PROP.—As 100 is to the quantity given, so is the strength given to the quantity at proof.

(24.) Reduce 40 gallons, at 30 per cent. over proof, to proof.

As 100 : 40 (quantity) : : 130 (30 over proof) : 52 (gallons at proof.) Ans.

(25.) Reduce 25½ gallons, at 32 per cent. under proof, to proof.

As 100 : 25·5 (quantity) : : 68 (32 under proof) : 17·34 (galls. at pf.) Ans.

The same result will be obtained if we multiply the quantity by the excess or deficiency over or under proof, and divide by 100; then add the quotient to the quantity, if over proof; and subtract it, if under proof; the sum or difference, as the case may be, will be the answer.

4th. If, after division, there be any remainder, its value may be found by reducing it to the lower denominations respectively, and dividing by the first term, as in Compound Division.

---

### *To reduce Spirits from any given, to any required, Strength.*

PROP.—As the given strength is to unity, so is the product of the given quantity and the given strength to the quantity at the required strength.

(26.) Reduce 70 gallons at proof, to 30 per cent. under proof.
Given quantity 70
Given strength 100

As 70 (30 under proof) : 1 : : 7000 : 100 (gals. at 30 per cent. under proof.)

(27.) Reduce 32 gallons, at 25 per cent. under proof, to 20 over proof.
Given strength 75 = 25 under proof.
Given quantity 32

As 120 (20 over proof) : 1 : : 2400 : 20 (gallons at 20 over proof.) Ans. (See Roose's "Guide," and Gutteredge's "Universal Gauger.")

### CONTRACTIONS, &c.

The second and third terms being multiplied together, it is evident that it is of no importance, so far as the result is concerned, which of these terms stands the first in stating the question. Hence, in some of the preceding examples, the second term, according to the rule given in the text, has been made the third, and *vice versa.*

Sometimes questions of proportion may be more readily performed by one of the following rules; either of which, it will be seen, produces the same result as the rule above referred to.

1st. Divide the first term by the second or third (so as to avoid the necessity of multiplying the second by the third); divide the remaining term by the quotient, and the last quotient will be the answer.

2nd. Divide the second and third terms by the first; multiply the quotient by the remaining term, and the product will be the answer.

### INVERSE PROPORTION.

Sometimes a distinction is made between Direct and Inverse Proportion, the former being limited to cases where more requires more, or less requires less; and the latter, to cases where more requires less, or less requires more; and the distinction in stating the questions being, that in Direct Proportion, the demanding number is the third term, and the second and third terms are multiplied together; and that in Inverse Proportion, the demanding number is the first term, and the first and second are multiplied together. This distinction, however, is unnecessary, if attention be paid to the nature of the question; which, after a little practice, may always be so arranged, as to produce the given result by the application of the foregoing rules and examples.

## 8. *Practice.*

Rules of Practice are certain expeditious methods of casting up accounts; and they consist chiefly of the most general contractions of the Rule of Three, when either the first or third term is unity.*

Rule I.—If it be required to find the value of any number of articles corresponding with the number of a higher or lower denomination, the process of multiplying or dividing by that number may be saved, by simply changing the name of the given number.†

---

DOUBLE RULE OF THREE.

When five numbers are given, three containing a supposition, and the other two a demand, an answer may sometimes be obtained by what is called the "Double Rule of Three, or, Rule of Five." But as such questions can always, and sometimes more readily, be answered by two operations of the Rule of Three, only one example, showing the usual mode of working, will be given.

(28.) If 100 men make 3 miles of road in 27 days, in how many days will 150 men make 5 miles ?

| Men. | Days. | Men. |
|---|---|---|
| 150 : | 27 : : | 100 |
| 3 miles | | 5 miles |
| 450 | | 500 |
| | | 27 |
| | 450 ) 13500 ( 30 days. Ans. | |

The sum which is like the number required (days) is made the middle term of the first line; two other terms, like one another, are made the first and third terms of the same line; the remaining numbers are made the first and third terms of the second line; the sums under each other are multiplied together, and the products, with the middle number, worked as in Common Proportion. The same question might be performed by two operations, thus:

If 150 men : 27 days : : 100 men : 18 days.
If 3 miles : 18 days : : 5 miles : 30 days. Ans.

* Rules of Practice in mental arithmetic, like contractions and arbitraries in short-hand writing, will always vary according to the particular business to be performed, and the minds engaged upon them. A few of the most common and useful rules and examples are selected; and, upon these, others may be easily constructed.

† EXAMPLES IN PRACTICE.

To multiply farthings by { 4, call them pence. 48, call them shillings. 960, call them pounds }
To multiply pence by { 12, call them shillings. 240, call them pounds. }
To multiply shillings by 20, call them pounds.

RULE II.—If the given price be an aliquot or even part of a penny, shilling, or pound, divide the given quantity by such aliquot or even part for the answer in the next higher denomination.*

---

To divide by
- 4, call pence, farthings.
- 48, call shillings, farthings.
- 960, call pounds, farthings.
- 12, call pence, shillings.
- 240, call pence, pounds.
- 20, call shillings, pounds.

Other rules, founded on the foregoing, will readily be adopted, if required in practice. For instance, 1 cwt., at 1d. per lb., amounts to 9s. 4d.; therefore, to find the value of a cwt. when the price of a lb. is given, call every penny in the price 9s. 4d., and reckon accordingly: thus,

(1.) 1 cwt. at 6d. = 9s. 4d. × 6 = £2 16s.

Again, to find the value of 1 dozen articles, the price in pence may be called shillings; and if there are any farthings in the price, 3d. may be added for each.

(2.) Required the duty on 12 (or 1 dozen) bushels of malt, at 2s. 7d.
2s. 7d. = 31d., which, taken as shillings, is £1 11s. Ans.

(3.) Required the duty on 48 (or 4 dozen) bushels, at the same rate.
2s. 7d. = 31d., and £1 11s. × 4 = £6 4s. Ans.

EXAMPLES APPLICABLE TO RULE II.

(4.) What is the duty on 2368 gallons of vinegar, at 2d. per gallon?

(2d. = $\frac{1}{6}$ of a shilling) 6 ) 2368

20 ) 394 8

Ans. 19 14s. 8d.

If the aliquot part is not known or readily worked, it may be divided into several aliquot parts, and each worked according to the above rule; or it may often be divided so that the less will be aliquot parts of the greater.

(5.) What is the duty on 784900 pounds of flint glass, at 6s. 8d. per 100 pounds?

(6s. 8d. = $\frac{1}{3}$ of a £) 3 ) 7849|00

Ans. 2616 6s. 8d.

(6.) What is the value of 4400 pounds, at ¾d. per pound?

(¾d. = $\frac{1}{16}$ of a shil.) 16 { 8 ) 4400
2 ) 550

Ans. £13 15s. = 275

(7.) What is the duty on 8464 cwt. of common bottles, at 7s. per cwt.?

5 = $\frac{1}{4}$, 2 = $\frac{1}{10}$ } of a £) 4, 10 } 8464

2116

846 8

£2962 8s. Ans.

---

* An aliquot part is an even fraction of anything: thus, 6d. is the aliquot part of a shilling, namely, one-half. (See the Tables at the end of the chapter, containing the aliquot parts of money, weights, measures, &c., in most common use.)

RULE III.—If the given number has reference to per centage, the number may either be divided by the aliquot part of £100, as in Rule II., or it may be multiplied by the rate per cent., and two figures cut off from the right of the units.*

---

If the price contains pounds, the given quantity will require to be multiplied by the number of pounds before the aliquot parts of the lower denomination are taken.

(8.) What is the duty on 568 cwt. of broad glass, at £1 10s. per cwt.?

(10s.=½ of a £) 2 ) 568 pounds.
284 ten shillings.
£852 Ans.

(9.) What is the duty on 175 cwt. of crown glass, at £3 13s. 6d. per cwt?

| | | | | | |
|---|---|---|---|---|---|
| 10s. 0d. = ½ | | 175 cwt. | | | |
| 2 6 = ⅛ | | 3 | | | |
| 1 0 = $\frac{1}{20}$ | | 525 | | | |
| 13 6 | | 87 | 10 | | |
| | | 21 | 17 | 6 | |
| | | 8 | 15 | 0 | |
| | Ans. | £643 | 2s. | 6d. | |

This and similar questions may be performed by decimals. (See page 15, and the Tables of Decimals at the end.) Thus:

£3 13s. 6d. × 175 = 3·675 × 175 = 643·125 = £643 2s. 6d.

If there be any odd weight or measure in the quantity, an aliquot part of the integer may be taken and added to the amount found as above.

(10.) What is the value of 3 tons 5 cwt., at £7 9s. 3d. per ton ?

£7 9s. 3d. × 3 = £22 7s. 9d.
7 9 3 ÷ 4 = 1 17 3¾
Ans. £24 5 0¾

If the price be any even number of shillings under 20, the given number may be multiplied by half of it, doubling the first figure to the right for shillings, and the other figures are pounds.

* EXAMPLES APPLICABLE TO RULE III.

(11.) What is a year's interest of £56, at £5 per cent. per annum ?

(5 = $\frac{1}{20}$ of £100) $\frac{1}{20}$ ) 56
£2 16s. Ans.

Or thus: 56
5
2]80
20
16]00 £2 16s. Ans.

The same calculation will give the amount of auction duty on chattels in Great Britain, at 1s. in the pound, which is equal to £5 per cent. (See the Table of Auction Duty, &c., *infra.*) Five per cent. interest being ascertained, the interest at 7½ per cent. may be found by adding one-half; 4 per cent., by deducting one-fifth; 3 per cent., by deducting two-fifths; 2½ per cent., by dividing by 2; 2 per cent., by taking the half of 4, and so on.

**Rule IV.**—If the given quantity contains a fraction, multiply the price by the numerator of the fraction, and divide the product by the denominator; and the result, added to the value of the integral part, will be the answer.*

---

(12.) What is the commission on £7417 3s. 9d., at £4 per cent.?

```
                        £    s. d.
(4 = 1/25 of £100)  5 ) 7417  3  9
                        ----------
                    5 ) 1483  8  9
                        ----------
               Ans.    £296 13  9
                        ----------
```

Or thus: 7417 3s. 9d.

```
           4
-------------
296]68 15  0
    20
   ---
 13]75
    12
   ---
  9]00     £296 13s. 9d. Ans.
   ---
```

(13.) What is the premium on £825 16s., at £1 per cent.?

Here no multiplication of the per centage is necessary; the units may therefore be cut off, thus:

```
£8]25 16s.
      20
     ---
    5]16
      12
     ---
    1]92
       4
     ---    £  s.  d.
    3]68    8  5  1¾ Ans.
     ---
```

(14.) What is the auction duty on £782 10s., foreign produce, at 10s. per cent.?

```
           £   s.
10 = ½ ) 782  10
         -------
        3]91   5
          20
         ---
       18]25
          12
         ---
        3]00  Ans. £3 18s. 3d.
         ---
```

Or thus, decimally:

```
£782 10s. = 782.5
½ per cent.= ·005
           ------
           3·9125
               20
           ------
          18·2500
               12
           ------
           3·0000
```

To find the interest for any number of days, multiply the sum by the number of days, and the product by the rate per cent., and divide by 36500 (365 × 100); the quotient is the answer required.

* EXAMPLE APPLICABLE TO RULE IV.

(15.) What is the value of 1735⅜ gallons, at £1 5s. per gallon?

```
    £ s.
    1 5
      3
   ---
8 ) 3 15 ( 9s. 4½d.
   ---
```

```
                         £    s. d.
(5s. = ¼ of a £)    4 ) 1735
                         433 15  0
       The fraction           9  4½
                        -----------
                       £2169  4  4½
                        -----------
```

## 9. *Arithmetical Tables.*

### No. 1.

### STERLING MONEY.

| Farthings. | Pence. | Shillings. | Crowns. | Pound. |
|---|---|---|---|---|
| 4 | 1 | | | |
| 48 | 12 | 1 | | |
| 240 | 60 | 5 | 1 | |
| 960 | 240 | 20 | 4 | 1 |

£ signifies pounds; s., shillings; and d., pence.

### No. 2.

### PENCE TABLE.

| d. | s. | d. | d. | s. | d. | d. | s. | d. | d. | s. | d. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 are | 1 | 0 | 60 are | 5 | 0 | 114 are | 9 | 6 | 168 are | 14 | 0 | 228 are | 0 | 19 | 0 |
| 18.... | 1 | 6 | 70.... | 5 | 10 | 120.... | 10 | 0 | 170.... | 14 | 2 | 240 .. | 1 | 0 | 0 |
| 20.... | 1 | 8 | 72.... | 6 | 0 | 126.... | 10 | 6 | 180.... | 15 | 0 | 365 .. | 1 | 10 | 5 |
| 24.... | 2 | 0 | 80.... | 6 | 8 | 130.... | 10 | 10 | 190.... | 15 | 10 | 480 .. | 2 | 0 | 0 |
| 30.... | 2 | 6 | 84.... | 7 | 0 | 132.... | 11 | 0 | 192.... | 16 | 0 | 600 .. | 2 | 10 | 0 |
| 36.... | 3 | 0 | 90.... | 7 | 6 | 140.... | 11 | 8 | 200.... | 16 | 8 | 1200 .. | 5 | 0 | 0 |
| 40.... | 3 | 4 | 96.... | 8 | 0 | 144.... | 12 | 0 | 204.... | 17 | 0 | 2400 .. | 10 | 0 | 0 |
| 48.... | 4 | 0 | 100.... | 8 | 4 | 150.... | 12 | 6 | 210.... | 17 | 6 | 3600 .. | 15 | 0 | 0 |
| 50.... | 4 | 2 | 108.... | 9 | 0 | 156.... | 13 | 0 | 216.... | 18 | 0 | 4800 .. | 20 | 0 | 0 |
| 54.... | 4 | 6 | 110.... | 9 | 2 | 160.... | 13 | 4 | 220.... | 18 | 4 | 12000 .. | 50 | 0 | 0 |

The multiples and sub-multiples of 240 (the number of pence in a pound) will be easily seen by the foregoing table: thus, ½ of 240 (being 10s.) = 120; ¼ (being 5s.) = 60; twice 240 (or £2) = 480, &c.

### No. 3.

### CURRENT BRITISH COINS.

| GOLD. | VALUE. | | | WEIGHT. | | | SILVER. | VALUE. | | | WEIGHT. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | oz. | dwt | gr. | | £ | s. | d. | oz. | dwt | gr. |
| Five Sovereign Piece ...... | 5 | 0 | 0 | 1 | 5 | 16·37 | Crown ........ | 0 | 5 | 0 | 0 | 18 | 4·36 |
| Double Sovergn. | 2 | 0 | 0 | 0 | 10 | 6·548 | Half-Crown ... | 0 | 2 | 6 | 0 | 9 | 2·18 |
| Guinea ........ | 1 | 1 | 0 | 0 | 5 | 9½ | Shilling ....... | 0 | 1 | 0 | 0 | 3 | 15·27 |
| Sovereign ..... | 1 | 0 | 0 | 0 | 5 | 3·274 | Sixpence ....... | 0 | 0 | 6 | 0 | 1 | 19·63 |
| Half-Guinea .. | 0 | 10 | 6 | 0 | 2 | 16¼ | BOULTON'S COPPER. | | | | | | |
| Half-Sovereign. | 0 | 10 | 0 | 0 | 2 | 13·637 | Penny.......... | 0 | 0 | 1 | 1oz. | 0drs. | |
| Seven-Shilling Piece ...... | 0 | 7 | 0 | 0 | 1 | 19 | Halfpenny .... | 0 | 0 | ½ | 0 — | 8 — | |
| | | | | | | | Farthing ...... | 0 | 0 | ¼ | 0 — | 4 — | |

The usual value of gold is nearly £4 an ounce, or 2d. a grain; and that of silver is nearly 5s. an ounce. 22 parts of fine gold, with 2 parts of copper, are esteemed the standard for gold coin; and 11 oz. 2 dwt. of fine silver, with 18 dwts. of copper, the standard for silver coin.

## No. 4.

## DECIMAL *and* FRACTIONAL PARTS *of a* POUND STERLING, *for calculating* PRICES, DUTIES, *&c.*

| Pence. | Decimals. | Pence. | Decimals. | Pence. | Decimals. | Pence. | Decimals. | Pence. | Decimals. | Pence. | Decimals. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | ·001042 | 2¼ | ·009375 | 4¼ | ·017708 | 6¼ | ·026042 | 8¼ | ·034375 | 10¼ | ·042708 |
| ½ | ·002083 | 2½ | ·010417 | 4½ | ·01875 | 6½ | ·027083 | 8½ | ·035417 | 10½ | ·04375 |
| ¾ | ·003125 | 2¾ | ·011458 | 4¾ | ·019792 | 6¾ | ·028125 | 8¾ | ·036458 | 10¾ | ·044792 |
| 1 | ·004166 | 3 | ·0125 | 5 | ·020833 | 7 | ·029166 | 9 | ·0375 | 11 | ·045833 |
| 1¼ | ·005208 | 3¼ | ·013542 | 5¼ | ·021875 | 7¼ | ·030208 | 9¼ | ·038542 | 11¼ | ·046875 |
| 1½ | ·006250 | 3½ | ·014583 | 5½ | ·022917 | 7½ | ·03125 | 9½ | ·039583 | 11½ | ·047917 |
| 1¾ | ·007291 | 3¾ | ·015625 | 5¾ | ·023958 | 7¾ | ·032292 | 9¾ | ·040625 | 11¾ | ·048958 |
| 2 | ·008333 | 4 | ·016666 | 6 | ·025 | 8 | ·033333 | 10 | ·041666 | | |

| s. d. | Frac. | Dec. | s. d. | Frac. | Dec. | s. d. | Frac. | Dec. | s. | Frac. | Dec. | s. d. | Frac. | Dec. | s. | Frac. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 0 | $\frac{1}{20}$ | ·05 | 3 4 | $\frac{1}{6}$ | ·167 | 6 8 | $\frac{1}{3}$ | ·333 | 9 | $\frac{9}{20}$ | ·450 | 13 0 | $\frac{13}{20}$ | ·65 | 16 | $\frac{4}{5}$ | ·8 |
| 2 0 | $\frac{1}{10}$ | ·1 | 4 0 | $\frac{1}{5}$ | ·2 | 7 0 | $\frac{7}{20}$ | ·350 | 10 | $\frac{1}{2}$ | ·5 | 13 4 | $\frac{2}{3}$ | ·667 | 17 | $\frac{17}{20}$ | ·85 |
| 2 6 | $\frac{1}{8}$ | ·125 | 5 0 | $\frac{1}{4}$ | ·250 | 7 6 | $\frac{3}{8}$ | ·375 | 11 | $\frac{11}{20}$ | ·550 | 14 0 | $\frac{7}{10}$ | ·7 | 18 | $\frac{9}{10}$ | ·9 |
| 3 0 | $\frac{3}{20}$ | ·150 | 6 0 | $\frac{3}{10}$ | ·3 | 8 0 | $\frac{2}{5}$ | ·4 | 12 | $\frac{3}{5}$ | ·6 | 15 0 | $\frac{3}{4}$ | ·75 | 19 | $\frac{19}{20}$ | ·95 |

## No. 5.

## TABLE *of* FACTORS, *for* SALARIES, *&c.*

| Per an. | Per diem. | | Per an. | Per diem. | | Per an. | Per diem. | |
|---|---|---|---|---|---|---|---|---|
| | Decimal | Value | | Decimal | Value | | Decimal | Value. |
| £ | | s. d. | £ | | s. d. | £ | | £ s. d. |
| 5 | ·013698 | 0 3¼ | 60 | ·164383 | 3 3½ | 200 | ·547945 | 0 10 11½ |
| 10 | ·027397 | 0 6½ | 70 | ·191780 | 3 10 | 250 | ·684931 | 0 13 8¼ |
| 15 | ·041096 | 0 10 | 80 | ·219178 | 4 4½ | 300 | ·821918 | 0 16 5¼ |
| 20 | ·054794 | 1 1 | 85 | ·232877 | 4 8 | 400 | 1·095890 | 1 1 11 |
| 25 | ·068493 | 1 4½ | 90 | ·246575 | 4 11¼ | 500 | 1·369863 | 1 7 4¾ |
| 30 | ·082192 | 1 7¾ | 100 | ·273973 | 5 5¾ | 600 | 1·643836 | 1 12 10½ |
| 35 | ·095890 | 1 11 | 120 | ·328767 | 6 7 | 700 | 1·917808 | 1 18 4¼ |
| 40 | ·109589 | 2 2¼ | 140 | ·383562 | 7 8 | 800 | 2·191781 | 2 3 10 |
| 50 | ·136986 | 2 8¾ | 150 | ·410959 | 8 2½ | 900 | 2·465753 | 2 9 3¾ |
| 52 | ·142466 | 2 10¼ | 180 | ·493151 | 9 10¼ | 1000 | 2·739726 | 2 14 9½ |

**USE.**—Find the number of days in Table 25; multiply such number by the factor or sum in the above Table: the product will give the salary due. For a leap year, the factors will be somewhat different, and must be found as in page 39. If there be any deduction for superannuation allowance, it may be either taken from the salary, and the factor found for the difference, or it may be calculated upon the product, and deducted therefrom.

## No. 10.

## MEASURE *of* CAPACITY, *for* ALE, BEER, *&c.*

| lbs. wt. of distilled Water. | Cubic Inches. | Pints. | Quarts. | Gallons. | Firkins. | Kilderkins. | Barrels. | Hogsheads. | Puncheons. | Butts. | Tun. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1¼ | 34·659¼ | 1 | | | | | | | | | |
| 2½ | 69·318½ | 2 | 1 | | | | | | | | |
| 10 | 277·274 | 8 | 4 | 1 | | | | | | | |
| 90 | 2495·466 | 72 | 36 | 9 | 1 | | | | | | |
| 180 | 4990·932 | 144 | 72 | 18 | 2 | 1 | | | | | |
| 360 | 9981·864 | 288 | 144 | 36 | 4 | 2 | 1 | | | | |
| 540 | 14972·796 | 432 | 216 | 54 | 6 | 3 | 1½ | 1 | | | |
| 720 | 19963·728 | 576 | 288 | 72 | 8 | 4 | 2 | 1½ | 1 | | |
| 1080 | 29945·592 | 864 | 432 | 108 | 12 | 6 | 3 | 2 | 1½ | 1 | |
| 2160 | 59891·184 | 1728 | 864 | 216 | 24 | 12 | 6 | 4 | 3 | 2 | 1 |

Hhds. signifies hogsheads; B., barrel; F., firkin; galls., gallons.

## No. 11.

## MEASURE *of* CAPACITY, *for* WINE, SPIRITS, *&c.*

| lbs. wt. of distilled Water. | Cubic Inches. | Gills. | Pints. | Quarts. | Gallons. | Ankers. | Runlets. | Barrels. | Tierces. | Hogsheads. | Puncheon. | Pipes or Butts. | Tun. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/16 | 8·664 13/16 | 1 | | | | | | | | | | | |
| 1¼ | 34·659¼ | 4 | 1 | | | | | | | | | | |
| 2½ | 69·318½ | 8 | 2 | 1 | | | | | | | | | |
| 10 | 277·274 | 32 | 8 | 4 | 1 | | | | | | | | |
| 100 | 2772·740 | 320 | 80 | 40 | 10 | 1 | | | | | | | |
| 180 | 4990·932 | 576 | 144 | 72 | 18 | 1 4/5 | 1 | | | | | | |
| 315 | 8734·131 | 1008 | 252 | 126 | 31½ | 3 3/20 | 1¾ | 1 | | | | | |
| 420 | 11654·508 | 1344 | 336 | 168 | 42 | 4 1/5 | 2⅓ | 1⅓ | 1 | | | | |
| 630 | 17468·262 | 2016 | 504 | 252 | 63 | 6 3/10 | 3½ | 2 | 1½ | 1 | | | |
| 840 | 23291·016 | 2688 | 672 | 336 | 84 | 8 2/5 | 4⅔ | 2⅔ | 2 | 1⅓ | 1 | | |
| 1260 | 34936·524 | 4032 | 1008 | 504 | 126 | 12 3/5 | 7 | 4 | 3 | 2 | 1½ | 1 | |
| 2520 | 69873·048 | 8064 | 2016 | 1008 | 252 | 25 1/5 | 14 | 8 | 6 | 4 | 3 | 2 | 1 |

## No. 12.

## FRACTIONS *and* DECIMAL PARTS *of a* GALLON.

| Pints. | Solid Inches. | Fracts. | Decms. | Pints. | Solid Inches. | Fracts. | Decms. | Pints. | Solid Inches. | Fracts. | Decms. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼ | 8·665 | 1/32 | ·031 | 1⅓ | 46·212 | ⅙ | ·167 | 4 | 138·637 | ½ | ·500 |
| ½ | 17·330 | 1/16 | ·0625 | 1⅗ | 55·455 | ⅕ | ·200 | 5 | 173·296 | ⅝ | ·625 |
| ⅘ | 27·727 | 1/10 | ·1 | 2 | 69·318 | ¼ | ·250 | 6 | 207·955 | ¾ | ·75 |
| 1 | 34·659 | ⅛ | ·125 | 3 | 103·978 | ⅜ | ·375 | 7 | 242·615 | ⅞ | ·875 |

### No. 13.

## TABLE *for reducing* INCHES *into* GALLONS.

| Gallons. | Inches. | Gallons. | Inches. | Gallons. | Inches. | Gallons. | Inches. | Gallons. | Inches. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 277·274 | 51 | 14140·974 | 101 | 28004·674 | 151 | 41868·374 | 250 | 69318·5 |
| 2 | 554·548 | 52 | 14418·248 | 102 | 28281·948 | 152 | 42145·648 | 300 | 83182·2 |
| 3 | 831·822 | 53 | 14695·522 | 103 | 28559·222 | 153 | 42422·922 | 350 | 97045·9 |
| 4 | 1109·096 | 54 | 14972·796 | 104 | 28836·496 | 154 | 42700·196 | 400 | 110909·6 |
| 5 | 1386·370 | 55 | 15250·070 | 105 | 29113·770 | 155 | 42977·470 | 450 | 124773·3 |
| 6 | 1663·644 | 56 | 15527·344 | 106 | 29391·044 | 156 | 43254·744 | 500 | 138637·0 |
| 7 | 1940·918 | 57 | 15804·618 | 107 | 29668·318 | 157 | 43532·018 | 550 | 152500·7 |
| 8 | 2218·192 | 58 | 16081·892 | 108 | 29945·592 | 158 | 43809·292 | 600 | 166364·4 |
| 9 | 2495·466 | 59 | 16359·166 | 109 | 30222·866 | 159 | 44086·566 | 650 | 180228·1 |
| 10 | 2772·74 | 60 | 16636·440 | 110 | 30500·140 | 160 | 44363·840 | 700 | 194091·8 |
| 11 | 3050·014 | 61 | 16913·714 | 111 | 30777·414 | 161 | 44641·114 | 750 | 207955·5 |
| 12 | 3327·288 | 62 | 17190·988 | 112 | 31054·688 | 162 | 44918·388 | 800 | 221819·2 |
| 13 | 3604·562 | 63 | 17468·262 | 113 | 31331·962 | 163 | 45195·662 | 850 | 235682·9 |
| 14 | 3881·836 | 64 | 17745·536 | 114 | 31609·236 | 164 | 45472·936 | 900 | 249546·6 |
| 15 | 4159·110 | 65 | 18022·810 | 115 | 31886·510 | 165 | 45750·210 | 950 | 263410·3 |
| 16 | 4436·384 | 66 | 18300·084 | 116 | 32163·784 | 166 | 46027·484 | 1000 | 277274·0 |
| 17 | 4713·658 | 67 | 18577·358 | 117 | 32441·058 | 167 | 46304·758 | 1100 | 305001·4 |
| 18 | 4990·932 | 68 | 18854·632 | 118 | 32718·332 | 168 | 46582·032 | 1200 | 332728·8 |
| 19 | 5268·206 | 69 | 19131·906 | 119 | 32995·606 | 169 | 46859·306 | 1300 | 360456·2 |
| 20 | 5545·480 | 70 | 19409·180 | 120 | 33272·880 | 170 | 47136·580 | 1400 | 388183·6 |
| 21 | 5822·754 | 71 | 19686·454 | 121 | 33550·154 | 171 | 47413·854 | 1500 | 415911·0 |
| 22 | 6100·028 | 72 | 19963·728 | 122 | 33827·428 | 172 | 47691·128 | 1600 | 443638·4 |
| 23 | 6377·302 | 73 | 20241·002 | 123 | 34104·702 | 173 | 47968·402 | 1700 | 471365·8 |
| 24 | 6654·576 | 74 | 20518·276 | 124 | 34381·976 | 174 | 48245·676 | 1800 | 499093·2 |
| 25 | 6931·850 | 75 | 20795·550 | 125 | 34659·250 | 175 | 48522·950 | 1900 | 526820·6 |
| 26 | 7209·124 | 76 | 21072·824 | 126 | 34936·524 | 176 | 48800·224 | 2000 | 554548·0 |
| 27 | 7486·398 | 77 | 21350·098 | 127 | 35213·798 | 177 | 49077·498 | 2100 | 582275·4 |
| 28 | 7763·672 | 78 | 21627·372 | 128 | 35491·072 | 178 | 49354·772 | 2200 | 610002·8 |
| 29 | 8040·946 | 79 | 21904·646 | 129 | 35768·346 | 179 | 49632·046 | 2300 | 637730·2 |
| 30 | 8318·220 | 80 | 22181·920 | 130 | 36045·620 | 180 | 49909·320 | 2400 | 665457·6 |
| 31 | 8595·494 | 81 | 22459·194 | 131 | 36322·894 | 181 | 50186·594 | 2500 | 691185·0 |
| 32 | 8872·768 | 82 | 22736·468 | 132 | 36600·168 | 182 | 50463·868 | 2600 | 720912·4 |
| 33 | 9150·042 | 83 | 23013·742 | 133 | 36877·442 | 183 | 50741·142 | 2700 | 748639·8 |
| 34 | 9427·316 | 84 | 23291·016 | 134 | 37154·716 | 184 | 51018·416 | 2800 | 776367·2 |
| 35 | 9704·590 | 85 | 23568·290 | 135 | 37431·990 | 185 | 51295·690 | 2900 | 804094·6 |
| 36 | 9981·864 | 86 | 23845·564 | 136 | 37709·264 | 186 | 51572·964 | 3000 | 831822·0 |
| 37 | 10259·138 | 87 | 24122·838 | 137 | 37986·538 | 187 | 51850·238 | 3100 | 859549·4 |
| 38 | 10536·412 | 88 | 24400·112 | 138 | 38263·812 | 188 | 52127·512 | 3200 | 887276·8 |
| 39 | 10813·686 | 89 | 24677·386 | 139 | 38541·086 | 189 | 52404·786 | 3300 | 915004·7 |
| 40 | 11090·960 | 90 | 24954·660 | 140 | 38818·360 | 190 | 52682·060 | 3400 | 942731·6 |
| 41 | 11368·234 | 91 | 25231·934 | 141 | 39095·634 | 191 | 52959·334 | 3500 | 970459·0 |
| 42 | 11645·508 | 92 | 25509·208 | 142 | 39372·908 | 192 | 53236·608 | 3600 | 998186·4 |
| 43 | 11922·782 | 93 | 25786·482 | 143 | 39650·182 | 193 | 53513·882 | 3700 | 1025913·8 |
| 44 | 12200·056 | 94 | 26063·756 | 144 | 39927·456 | 194 | 53791·156 | 3800 | 1053641·2 |
| 45 | 12477·330 | 95 | 26341·030 | 145 | 40204·730 | 195 | 54068·430 | 3900 | 1081368·6 |
| 46 | 12754·604 | 96 | 26618·304 | 146 | 40482·004 | 196 | 54345·704 | 4000 | 1109096 |
| 47 | 13031·878 | 97 | 26895·578 | 147 | 40759·278 | 197 | 54622·978 | 5000 | 1386370 |
| 48 | 13309·152 | 98 | 27172·852 | 148 | 41036·552 | 198 | 54900·252 | 6000 | 1663644 |
| 49 | 13586·426 | 99 | 27450·126 | 149 | 41313·826 | 199 | 55177·526 | 7000 | 1940918 |
| 50 | 13863·700 | 100 | 27727·400 | 150 | 41591·100 | 200 | 55454·800 | 10000 | 2772740 |

### No. 14.

## MEASURE *of* CAPACITY, *for* CORN *and* DRY GOODS.

| lbs. wt. of distilled Water. | Cubic Inches. | Pints. | Quarts. | Pottles. | Gallons. | Pecks. | Bushels | Strikes. | Coombs. | Quarters. | Weys or Loads. | Last. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $1\frac{1}{4}$ | $34·659\frac{1}{4}$ | 1 | | | | | | | | | | |
| $2\frac{1}{2}$ | $69·318\frac{1}{2}$ | 2 | 1 | | | | | | | | | |
| 5 | 138·637 | 4 | 2 | 1 | | | | | | | | |
| 10 | 277·274 | 8 | 4 | 2 | 1 | | | | | | | |
| 20 | 554·548 | 16 | 8 | 4 | 2 | 1 | | | | | | |
| 80 | 2218·192 | 64 | 32 | 16 | 8 | 4 | 1 | | | | | |
| 160 | 4436·384 | 128 | 64 | 32 | 16 | 8 | 2 | 1 | | | | |
| 320 | 8872·768 | 256 | 128 | 64 | 32 | 16 | 4 | 2 | 1 | | | |
| 640 | 17745·536 | 512 | 256 | 128 | 64 | 32 | 8 | 4 | 2 | 1 | | |
| 3200 | 88727·680 | 2560 | 1280 | 640 | 320 | 160 | 40 | 20 | 10 | 5 | 1 | |
| 6400 | 177455·360 | 5120 | 2560 | 1280 | 640 | 320 | 80 | 40 | 20 | 10 | 2 | 1 |

### No. 15.

## FRACTIONAL *and* DECIMAL PARTS *of a* BUSHEL.

| Measure. | Solid Inches. | Fractions. | Decimals. | Measure. | Solid Inches. | Fractions. | Decimals. | Measure. | Solid Inches. | Fractions. | Decimals. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 pt. | 34·659 | $\frac{1}{64}$ | ·016 | $1\frac{1}{3}$ gal. | 369·699 | $\frac{1}{6}$ | ·167 | 18 qts. | 1247·733 | $\frac{9}{16}$ | ·5625 |
| 1 qt. | 69·318 | $\frac{1}{32}$ | ·031 | $1\frac{3}{5}$ gal. | 443·638 | $\frac{1}{5}$ | ·2 | 5 gal. | 1386·37 | $\frac{5}{8}$ | ·625 |
| 2 qts. | 138·637 | $\frac{1}{16}$ | ·0625 | 2 gal. | 554·548 | $\frac{1}{4}$ | ·25 | 22 qts. | 1525·007 | $\frac{11}{16}$ | ·6875 |
| $2\frac{2}{3}$ qt. | 184·849 | $\frac{1}{12}$ | ·083 | 10 qts. | 693·185 | $\frac{5}{16}$ | ·3125 | 6 gal. | 1663·644 | $\frac{3}{4}$ | ·75 |
| $3\frac{1}{5}$ qt. | 221·8192 | $\frac{1}{10}$ | ·1 | 3 gal. | 831·822 | $\frac{3}{8}$ | ·375 | 26 qts. | 1802·281 | $\frac{13}{16}$ | ·8125 |
| 1 gal. | 277·274 | $\frac{1}{8}$ | ·125 | 14 qts. | 970·459 | $\frac{7}{16}$ | ·4375 | 7 gal. | 1940·918 | $\frac{7}{8}$ | ·875 |
| 6 qts. | 415·911 | $\frac{3}{16}$ | ·1875 | 4 gal. | 1109·096 | $\frac{1}{2}$ | ·5 | 30 qts. | 2079·555 | $\frac{15}{16}$ | ·9375 |

### No. 16.

## DIMENSIONS *of the* IMPERIAL MEASURES *of* CAPACITY *in* INCHES *and* DECIMALS, *and also in* INCHES *and the nearest* FRACTIONS.

| Imperial Dry Measure. | Depths. | Inside Diameter. | Outside Diameter at Mouth. | Breadth at the Edge. | Height of the Heap. |
|---|---|---|---|---|---|
| | Inches. | Inches. | Inches. | Inches. | Inches. |
| Bushel .... | 8·0000<br>8 | 18·7892<br>$18\frac{13}{16}$ | 19·5000<br>$19\frac{1}{2}$ | ·3553<br>$\frac{3}{8}$ | 6·0000<br>6 |
| Half-bushel. | 6·3496<br>$6\frac{3}{8}$ | 14·9130<br>$14\frac{15}{16}$ | 15·4771<br>$15\frac{1}{2}$ | ·2820<br>$\frac{5}{16}$ | 4·7622<br>$4\frac{3}{4}$ |
| Peck...... | 5,0396<br>$5\frac{1}{16}$ | 11·8364<br>$11\frac{7}{8}$ | 12·2842<br>$12\frac{5}{16}$ | ·2239<br>$\frac{1}{4}$ | ·3·7797<br>$3\frac{3}{4}$ |
| Gallon..... | 4·0000<br>4 | 9·3946<br>$9\frac{3}{8}$ | 9·7500<br>$9\frac{3}{4}$ | ·1776<br>$\frac{3}{16}$ | 3·0000<br>3 |
| Half-gallon. | 3·1748<br>$3\frac{3}{16}$ | 7·4565<br>$7\frac{7}{16}$ | 7·7385<br>$7\frac{3}{4}$ | ·1410<br>$\frac{1}{8}$ | 2·3811<br>$2\frac{3}{8}$ |
| Quart...... | 2·5198<br>$2\frac{1}{2}$ | 5·9182<br>$5\frac{15}{16}$ | 6·1421<br>$6\frac{1}{8}$ | ·1119<br>$\frac{1}{8}$ | 1·8898<br>$1\frac{7}{8}$ |

## No. 17.

## TABLE *for reducing* INCHES *into* BUSHELS.

| Bushels. | Inches. | Bushels. | Inches. | Bushels. | Inches. | Bushels. | Inches. | Bushels. | Inches. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2218·192 | 51 | 113127·792 | 101 | 224037·392 | 151 | 334946·992 | 250 | 554548·0 |
| 2 | 4436·384 | 52 | 115345·984 | 102 | 226255·584 | 152 | 337165·184 | 300 | 665457·6 |
| 3 | 6654·576 | 53 | 117564·176 | 103 | 228473·776 | 153 | 339383·376 | 350 | 776367·2 |
| 4 | 8872·768 | 54 | 119782·368 | 104 | 230691·968 | 154 | 341601·568 | 400 | 887276·8 |
| 5 | 11090·960 | 55 | 122000·560 | 105 | 232910·160 | 155 | 343819·760 | 450 | 998186·4 |
| 6 | 13309·152 | 56 | 124218·752 | 106 | 235128·352 | 156 | 346037·952 | 500 | 1109096·0 |
| 7 | 15527·344 | 57 | 126436·944 | 107 | 237346·544 | 157 | 348256·144 | 550 | 1220005·6 |
| 8 | 17745·536 | 58 | 128655·136 | 108 | 239564·736 | 158 | 350474·336 | 600 | 1330915·2 |
| 9 | 19963·728 | 59 | 130873·328 | 109 | 241782·928 | 159 | 352692·528 | 650 | 1441824·8 |
| 10 | 22181·920 | 60 | 133091·520 | 110 | 244001·120 | 160 | 354910·720 | 700 | 1552734·4 |
| 11 | 24400·112 | 61 | 135309·712 | 111 | 246219·312 | 161 | 357128·912 | 750 | 1663644·0 |
| 12 | 26618·304 | 62 | 137527·904 | 112 | 248437·504 | 162 | 359347·104 | 800 | 1774553·6 |
| 13 | 28836·496 | 63 | 139746·096 | 113 | 250655·696 | 163 | 361565·296 | 850 | 1885463·2 |
| 14 | 31054·688 | 64 | 141964·288 | 114 | 252873·888 | 164 | 363783·488 | 900 | 1996372·8 |
| 15 | 33272·880 | 65 | 144182·480 | 115 | 255092·080 | 165 | 366001·680 | 950 | 2107282·4 |
| 16 | 35491·072 | 66 | 146400·672 | 116 | 257310·272 | 166 | 368219·872 | 1000 | 2218192·0 |
| 17 | 37709·264 | 67 | 148618·864 | 117 | 259528·464 | 167 | 370438·064 | 1100 | 2440011·2 |
| 18 | 39927·456 | 68 | 150837·056 | 118 | 261746·656 | 168 | 372656·256 | 1200 | 2661830·4 |
| 19 | 42145·648 | 69 | 153055·248 | 119 | 263964·848 | 169 | 374874·448 | 1300 | 2883649·6 |
| 20 | 44363·840 | 70 | 155273·440 | 120 | 266183·040 | 170 | 377092·640 | 1400 | 3105468·8 |
| 21 | 46582·032 | 71 | 157491·632 | 121 | 268401·232 | 171 | 379310·832 | 1500 | 3327288·0 |
| 22 | 48800·224 | 72 | 159709·824 | 122 | 270619·424 | 172 | 381529·024 | 1600 | 3549107·2 |
| 23 | 51018·416 | 73 | 161928·016 | 123 | 272837·616 | 173 | 383747·216 | 1700 | 3770926·4 |
| 24 | 53236·608 | 74 | 164146·208 | 124 | 275055·808 | 174 | 385965·408 | 1800 | 3992745·6 |
| 25 | 55454·800 | 75 | 166364·400 | 125 | 277274·000 | 175 | 388183·600 | 1900 | 4214564·8 |
| 26 | 57672·992 | 76 | 168582·592 | 126 | 279492·192 | 176 | 390401·792 | 2000 | 4436384·0 |
| 27 | 59891·184 | 77 | 170800·784 | 127 | 281710·384 | 177 | 392619·984 | 2100 | 4658203·2 |
| 28 | 62109·376 | 78 | 173018·976 | 128 | 283928·576 | 178 | 394838·176 | 2200 | 4880022·4 |
| 29 | 64327·568 | 79 | 175237·168 | 129 | 286146·768 | 179 | 397056·368 | 2300 | 5101841·6 |
| 30 | 66545·760 | 80 | 177455·360 | 130 | 288364·960 | 180 | 399274·560 | 2400 | 5323660·8 |
| 31 | 68763·952 | 81 | 179673·552 | 131 | 290583·152 | 181 | 401492·752 | 2500 | 5545480·0 |
| 32 | 70982·144 | 82 | 181891·744 | 132 | 292801·344 | 182 | 403710·944 | 2600 | 5767299·2 |
| 33 | 73200·336 | 83 | 184109·936 | 133 | 295019·536 | 183 | 405929·136 | 2700 | 5989118·4 |
| 34 | 75418·528 | 84 | 186328·128 | 134 | 297237·728 | 184 | 408147·328 | 2800 | 6210937·6 |
| 35 | 77636·720 | 85 | 188546·320 | 135 | 299455·920 | 185 | 410365·520 | 2900 | 6432756·8 |
| 36 | 79854·912 | 86 | 190764·512 | 136 | 301674·112 | 186 | 412583·712 | 3000 | 6654576·0 |
| 37 | 82073·104 | 87 | 192982·704 | 137 | 303892·304 | 187 | 414801·904 | 3100 | 6876395·2 |
| 38 | 84291·296 | 88 | 195200·896 | 138 | 306110·496 | 188 | 417020·096 | 3200 | 7098214·4 |
| 39 | 86509·488 | 89 | 197419·088 | 139 | 308328·688 | 189 | 419238·288 | 3300 | 7320033·6 |
| 40 | 88727·680 | 90 | 199637·280 | 140 | 310546·880 | 190 | 421456·480 | 3400 | 7541852·8 |
| 41 | 90945·872 | 91 | 201855·472 | 141 | 312765·072 | 191 | 423674·672 | 3500 | 7763672·0 |
| 42 | 93164·064 | 92 | 204073·664 | 142 | 314983·264 | 192 | 425892·864 | 3600 | 7985491·2 |
| 43 | 95382·256 | 93 | 206291·856 | 143 | 317201·456 | 193 | 428111·056 | 3700 | 8207310·4 |
| 44 | 97600·448 | 94 | 208510·048 | 144 | 319419·648 | 194 | 430329·248 | 3800 | 8429129·6 |
| 45 | 99818·640 | 95 | 210728·240 | 145 | 321637·840 | 195 | 432547·440 | 3900 | 8650948·8 |
| 46 | 102036·832 | 96 | 212946·432 | 146 | 323856·032 | 196 | 434765·632 | 4000 | 8872768 |
| 47 | 104255·024 | 97 | 215164·624 | 147 | 326074·224 | 197 | 436983·824 | 5000 | 11090960 |
| 48 | 106473·216 | 98 | 217382·816 | 148 | 328292·416 | 198 | 439202·016 | 6000 | 13309152 |
| 49 | 108691·408 | 99 | 219601·008 | 149 | 330510·608 | 199 | 441420·208 | 7000 | 15527344 |
| 50 | 110909·600 | 100 | 221819·200 | 150 | 332728·800 | 200 | 443638·400 | 10000 | 22181920 |

### No. 18.

### FACTORS *for converting* OLD MEASURES *of* CAPACITY *into* NEW, *and the contrary.*

| | By Decimals. | | | By Vulgar Fractions. | | |
|---|---|---|---|---|---|---|
| | Corn Measure. | Wine Measure. | Ale Measure. | Corn Measure. | Wine Measure. | Ale Measure. |
| To convert Old Measure to New. | ·96943 | ·83311 | 1·01704 | $\frac{31}{32}$ | $\frac{5}{6}$ | $\frac{60}{59}$ |
| To convert New Measure to Old. | 1·03153 | 1·20032 | ·98324 | $\frac{32}{31}$ | $\frac{6}{5}$ | $\frac{59}{60}$ |

The *Old Ale Gallon* contained........ 282 cubic inches.
The *Old Wine Gallon* contained...... 231 cubic inches.
The *Old Winchester Bushel* contained $2150\frac{2}{5}$ cubic inches.
The *Imperial Gallon* contains ........ 277·274 cubic inches.
The *Corn Bushel* contains............ 2218·192 cubic inches.

### No. 19.

## LINEAL MEASURE.

| Inches. | Gunter's Links. | Feet. | Yards. | Fathoms. | Rods, Poles, or Perches. | Gunter's Chains. | Furlongs. | Mile. |
|---|---|---|---|---|---|---|---|---|
| $7\frac{23}{25}$ | 1 | | | | | | | |
| 12 | $1\frac{17}{33}$ | 1 | | | | | | |
| 36 | $4\frac{6}{11}$ | 3 | 1 | | | | | |
| 72 | $9\frac{1}{11}$ | 6 | 2 | 1 | | | | |
| 198 | 25 | $16\frac{1}{2}$ | $5\frac{1}{2}$ | $2\frac{3}{4}$ | 1 | | | |
| 792 | 100 | 66 | 22 | 11 | 4 | 1 | | |
| 7920 | 1000 | 660 | 220 | 110 | 40 | 10 | 1 | |
| 63360 | 8000 | 5280 | 1760 | 880 | 320 | 80 | 8 | 1 |

### No. 20.

## SQUARE MEASURE.

| Square Inches. | Square Links. | Square Feet. | Square Yards. | Sq. Rods, Perches, or Poles. | Square Chains. | Square Roods. | Square Acres. | Sq. Mile. |
|---|---|---|---|---|---|---|---|---|
| $62\frac{454}{625}$ | 1 | | | | | | | |
| 144 | $2\frac{322}{1089}$ | 1 | | | | | | |
| 1296 | $20\frac{80}{121}$ | 9 | 1 | | | | | |
| 39204 | 625 | $272\frac{1}{4}$ | $30\frac{1}{4}$ | 1 | | | | |
| 627264 | 10000 | 4356 | 484 | 16 | 1 | | | |
| 1568160 | 25000 | 10890 | 1210 | 40 | $2\frac{1}{2}$ | 1 | | |
| 6272640 | 100000 | 43560 | 4840 | 160 | 10 | 4 | 1 | |
| 4014489600 | 64000000 | 27878400 | 3097600 | 102400 | 6400 | 2560 | 640 | 1 |

## No. 21.

## FACTORS, DIVISORS, *and* GAUGE POINTS, *for reducing* CUBIC INCHES *into* SQUARE *and* CIRCULAR AREAS.

| | Factors for | | Divisors for | | Gauge Points for | |
|---|---|---|---|---|---|---|
| | Squares | Circles. | Squares | Circles. | Squares | Circles. |
| Inch the Area of Unity | 1 | ·785398 | 1 | 1·27324 | 1 | 1·128 |
| Superficial Foot...... | ·006944 | ·005454 | 144 | 183·34 | 12 | 13·54 |
| Solid Foot............ | ·000578 | .000454 | 1728 | 2200·16 | 41·57 | 46·91 |
| Imperial Gallon...... | ·003606 | ·002832 | 277·274 | 353·036 | 16·65 | 18·79 |
| Imperial Bushel...... | ·000451 | ·000354 | 2218·192 | 2824·29 | 47·10 | 53·14 |

For the divisors, &c., relating to glass and soap, see the Acts of Parliament, and Board Orders.

## No. 22.

## CUBIC, *or* SOLID MEASURE.

| Cubic Inches. | Cubic Feet. | Cubic Yards. |
|---|---|---|
| 1728 | 1 | |
| 46656 | 27 | 1 |

## No. 23.

## ANGULAR MEASURE; *or*, DIVISIONS *of the* CIRCLE.

| Seconds. | Minutes. | Degrees. | Signs. | Quadrant. | Semicircle | Circle. |
|---|---|---|---|---|---|---|
| 60 | 1 | | | | | |
| 3600 | 60 | 1 | | | | |
| 108000 | 1800 | 30 | 1 | | | |
| 324000 | 5400 | 90 | 3 | 1 | | |
| 648000 | 10800 | 180 | 6 | 2 | 1 | |
| 1296000 | 21600 | 360 | 12 | 4 | 2 | 1 |

Signs are marked s.; degrees, °; minutes, ′; seconds, ″.

The diurnal motion of the earth, reduced to time, is as follows:—360 degrees = 24 hours; 15 degrees = 1 hour; 1 degree = 4 minutes.

The days in each month may be found by the following couplets:—

Thirty days has September,
April, June, and November;
All the rest have thirty-one,
Excepting February alone,
Which has but twenty-eight days clear,
And twenty-nine in each leap year.

## No. 24.

## TIME.

| Seconds. | Minutes. | Hours. | Days. | Weeks. | Months. | Year. |
|---|---|---|---|---|---|---|
| 60 | 1 | | | | | |
| 3600 | 60 | 1 | | | | |
| 86400 | 1440 | 24 | 1 | | | |
| 604800 | 10080 | 168 | 7 | 1 | | |
| 2419200 | 40320 | 672 | 28 | 4 | 1 | |
| 31557600 | 525960 | 8766 | 365¼ | 52 | 13 Lunar or 12 Cal. | 1 |

365 days, or 52 weeks and 1 day = 1 common year; 365¼ days = 1 Julian year; 366 days = 1 leap year, which is every fourth year.

## No. 25.

## TABLE *for finding the* NUMBER *of* DAYS *between one* MONTH *and another.*

| | | FROM | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
| TO | January.. | 0 | 334 | 306 | 275 | 245 | 214 | 184 | 153 | 122 | 92 | 61 | 31 |
| | February | 31 | 0 | 337 | 306 | 276 | 245 | 215 | 184 | 153 | 123 | 92 | 62 |
| | March .. | 59 | 28 | 0 | 334 | 304 | 273 | 243 | 212 | 181 | 151 | 120 | 90 |
| | April .... | 90 | 59 | 31 | 0 | 335 | 304 | 274 | 243 | 212 | 182 | 151 | 121 |
| | May .... | 120 | 89 | 61 | 30 | 0 | 334 | 304 | 273 | 242 | 212 | 181 | 151 |
| | June .... | 151 | 120 | 92 | 61 | 31 | 0 | 335 | 304 | 273 | 243 | 212 | 182 |
| | July .... | 181 | 150 | 122 | 91 | 61 | 30 | 0 | 334 | 303 | 273 | 242 | 212 |
| | August .. | 212 | 181 | 153 | 122 | 92 | 61 | 31 | 0 | 334 | 304 | 273 | 243 |
| | Septembr. | 243 | 212 | 184 | 153 | 123 | 92 | 62 | 31 | 0 | 335 | 304 | 274 |
| | October .. | 273 | 242 | 214 | 183 | 153 | 122 | 92 | 61 | 30 | 0 | 334 | 304 |
| | November | 304 | 273 | 246 | 214 | 184 | 153 | 123 | 92 | 61 | 31 | 0 | 335 |
| | December | 334 | 303 | 275 | 244 | 214 | 183 | 153 | 122 | 91 | 61 | 30 | 0 |

### EXAMPLES.

(1.) From the 1st of January to the 1st of December, 334 days.
(2.) From the 1st of June to the 1st of April, 304 days.
(3.) From the 10th of January to the 12th of June, 151 + 2 = 153 days.
(4.) From the 8th of June to the 1st of January, 214 — 7 = 207 days.

If both days are inclusive, add one day. If it be leap year, and February be included, add one day.

## No. 26.

## SPECIFIC GRAVITIES.

SOLIDS.

| | |
|---|---|
| Apple tree, dry | ·793 |
| Ash, dry | ·800 |
| Beech, dry | ·852 |
| Boxwood | 1·030 |
| ——, Dutch | ·912 |
| Brick | 2·000 |
| Brass, cast | 8·395 |
| Butter | ·9423 |
| Chalk, British | 2·784 |
| ——, Spanish | 2·790 |
| Clay | 2·160 |
| Coal | 1·250 to 1·308 |
| Copper | 7·700 |
| ——, cast | 7·788 to 8·788 |
| Cork | ·240 |
| Earth, light | 1·984 |
| Ebony | 1·290 |
| Elm | ·600 to ·671 |
| Fat, beef | ·9232 to ·9480 |
| ——, mutton | ·9235 |
| Feldspar | 2·500 |
| Fir | ·490 to ·600 |
| ——, yellow | ·657 |
| Glass, crown | 2·527 |
| ——, German sheet | 2·533 |
| ——, broad | 2·721 |
| ——, plate | 2·432 |
| ——, comn. bottle | 2·724 |
| Glass, flint | 3·277 |
| Gold, pure | 19·2587 |
| ——, hammered | 19·362 |
| ——, sovereign | 18·769 |
| ——, trinket | 17·647 |
| Granite, Aberdeen, bluish | 2·625 to 2·654 |
| ——, Cornish | 2·662 |
| ——, Bretagne gray | 2·738 |
| Gypsum | 2·167 to 2·311 |
| Honey | 1·456 |
| Iron, cast | 7·207 |
| ——, bar | 7·788 |
| ——, stone | 4·323 |
| Lard | ·948 |
| Lead, cast, | 11·352 |
| Limestone, green | 3·182 |
| Litharge | 6·300 |
| Logwood | ·913 |
| Mahogany | 1·060 |
| Mercury, 30 deg. | 13·619 |
| ——, 60 deg. | 13·580 |
| ——, solid, 40 below zero | 15·632 |
| Oak | 1·1700 |
| ——, dry | ·925 |
| Porcelain, china | 2·380 |
| Poplar, dry | ·383 |
| Pumice stone | ·915 |
| Sand | 1·520 |
| Salt | 2·130 |
| Silver, virgin | 10·474 |
| ——, hammered | 10·511 |
| ——, shilling | 10·534 |
| Slate, clay | 2·670 |
| Soap, hard, hot | ·990 |
| ——, cold | 1·0216 |
| ——, soft, cold | 1·08801 |
| ——, silicated, hot | 1·1884 |
| cold | 1·2263 |
| Steel | 7·840 |
| ——, hard | 7·816 |
| Stone, paving | 2·416 |
| ——, Portland | 2·570 |
| Sugar, loaf | 1·606 |
| Talc | 2·700 to 2·800 |
| Tallow | ·942 |
| Tin, pure Cornish, | 7·291 |
| ——, cast | 7·291 |
| Wax | ·897 |
| Willow | ·585 |
| Zinc, pure | 7·1908 |
| ——, in its usual state | 6·862 |

FLUIDS, &c.

| | |
|---|---|
| Acid, nitric | 1·270 |
| ——, muriatic | 1·940 |
| ——, sulphuric | 1·840 |
| Alcohol, 60° | ·825 |
| ——, proof, 51° | ·923 |
| ——, commercial | ·837 |
| Atmospheric air | ·00303 |
| Beer, pale | 1·023 |
| ——, brown | 1·034 |
| Carbonic acid gas | ·00174 |
| Cyder | 1·018 |
| Ether, sulphuric, | ·730 |
| ——, nitric | ·908 |
| Hydrogen gas | 00008 |
| Milk, cows' | 1·032 |
| Oil, olive | ·9153 |
| —, linseed | ·940 |
| —, whale | ·9233 |
| Oxygen gas | ·00132 |
| Spirits (*see* Alcohol). | |
| Turpentine, spirits | ·870 |
| Vinegar | 1 010 |
| ——, distilled | 1·025 |
| Water, distilled | 1·000 |
| ——, sea | 1·026 |
| ——, spring | 1·0017 |
| Wine, Burgundy, | ·992 |
| ——, Bordeaux | ·994 |
| ——, Champagne, white | ·998 |
| ——, Claret | ·994 |
| ——, Canary | 1·033 |
| ——, Constance | 1·082 |
| ——, Madeira | 1·038 |
| ——, Malaga | 1·022 |
| ——, Port, red and white | ·997 |
| ——, Sherry | ·992 |
| ——, Tokay | 1·054 |

As a cubic foot of water is 1000 oz., and 1·000 is taken to be the specific gravity of water, so a Table of specific gravities expresses the ounces in a cubic foot of each of the bodies. (See page 26.) At 70 degrees, the specific gravity of water is ·99913; at 38 degrees, 1·00113; at 54 degrees, 1·00064; and at 62 degrees, 1000. The difference between 62 and 39 degrees, in a gallon of 277·274 inches, is one-third of a cubic inch.—*Million of Facts.*

In the above Table, the specific gravities of soap are those on which the calculations are made for charging the duty. The specific gravities of glass are from experiments made by the Surveying-General Examiners, on a special survey, and differ materially from former experiments; the other particulars are from various authors.

## No. 27.

## MISCELLANEOUS WEIGHTS *and* MEASURES.

*Apothecaries' Weight.*
20 grains make 1 scruple.
3 scruples .... 1 dram.
8 drams ...... 1 ounce.

*Bread.*
2 pounds...... ½-quartern loaf.
4 pounds...... 1 quartern loaf.

*Bricks.*
500.............. 1 load.

*Candles.*
120 pounds...... 1 barrel.

*Cheese and Butter.*
8 pounds...... 1 nail.
32 cloves ...... 1 wey (Essex).
42 cloves ...... 1 wey (Suffolk).
56 pounds...... 1 firkin.
224 pounds...... 1 barrel.

*Cloth.*
2¼ inches ...... 1 nail.
4 nails ........ 1 quarter.
3 quarters .... 1 Flemish ell.
4 quarters .... 1 yard.
5 quarters .... 1 English ell.
6 quarters .... 1 French ell.

*Coals.*
88 pounds...... 1 bushel.
3168 pounds...... 1 chaldron.
224 pounds...... 1 sack.
10 sacks ...... 1 ton.

*Corn.*
5 bushels .... 1 load.
40 bushels .... 1 cart.
60 pounds...... 1 bush. of wheat
52 pounds...... 1 bushel of rye.
47 pounds...... 1 bush. of barley
88 pounds...... 1 bush. of oats.

*Flour.*
14 pounds...... 1 peck.
56 pounds...... 1 bushel.
280 pounds...... 1 sack.
5 bushels .... 1 sack.

*Glass.*
120 pounds...... 1 seam.

*Hay (new).*
60 pounds...... 1 truss.

*Hay (old).*
56 pounds...... 1 truss.
36 trusses...... 1 load.

*Hops.*
112 pounds...... 1 packet (Surrey and Sussex).
250 pounds...... 1 bag (Kent).

*Meat.*
8 pounds...... 1 stone.

*Oatmeal.*
200 pounds...... 1 barrel.

*Oil (train).*
9 pounds 6 ounces, 1 gallon.

*Oil (sweet).*
236 pounds make 1 tun.

*Paper.*
20 sheets ...... 1 quire, outsides
24 sheets ...... 1 quire, insides.
20 quires ...... 1 ream.
21½ quires...... 1 printer's ream
2 reams ...... 1 bundle.
10 reams ...... 1 bale.

*Parchment.*
60 skins........ 1 roll.

*Potatoes.*
200 pounds...... 1 barrel.

*Raisins.*
112 pounds...... 1 barrel.

*Rice.*
168 pounds...... 1 barrel.

*Salt.*
14 pounds...... 1 peck.
56 pounds...... 1 bushel.
42 bushels .... 1 ton.

*Soap.*
64 pounds, or
8 gallons .. 1 firkin.
256 pounds...... 1 barrel.

*Straw.*
36 pounds...... 1 truss.

*Tea.*
48 lbs. (about).. 1 chest.

*Tiles.*
1000.............. 1 load.

*Tobacco.*
2 to 3 cwt. .... 1 barrel.

*Water.*
1000 ounces....... 1 cubic foot.

*Wine.*
138 gallons...... 1 pipe of Port.
140 gallons...... 1 do. of Lisbon.
110 gallons...... 1 do. of Madeira.
120 gallons...... 1 do. Teneriffe.
57 gallons...... 1 hhd. of Claret.
36 gallons...... 1 aum of Hock.
20 gallons...... 1 hhd. of Sherry
130 gallons...... 1 butt of Sherry.

*Wood.*
1000 billets ...... 1 cord.
10 cwt. ......... 1 cord.
108 feet ......... 1 stack.
128 feet ......... 1 cord.

*Wool.*
7 pounds...... 1 clove.
2 cloves ...... 1 stone.
2 stones ...... 1 tod.
6½ tods........ 1 Wey.
2 weys ........ 1 sack.
12 sacks, or
4368 pounds...... 1 last.
240 pounds...... 1 pack.

## CHAPTER II.

# MENSURATION.

Mensuration comprehends those branches of mathematics which have for their object the comparison of geometrical quantities,* and the determination of their proportions to each other; in a limited sense, it is applied to a system of rules and methods by which numerical measures of magnitudes are obtained.

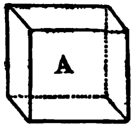
*Magnitudes* are lines, surfaces, and bodies, or solids.

A *point* is said to be the inceptive of magnitude. It is a mark of position, but has no parts or dimensions.

A *line* has one dimension, length, without breadth, its bounds or extremes being points; as A B.

A *surface*, or *superficies*, has two dimensions, length and breadth, its bounds or extremes being lines; as C.

A *solid* has three dimensions, length, breadth, and thickness, its bounds or extremes being superficies; as A.



In all practical applications of mathematics, it is necessary to express magnitudes of every kind by numbers; for which purpose, a line of some determinate length, or a surface or solid of some determinate figure and magnitude, is assumed as the measuring-unit, and the number of units contained in any line, surface, or solid, is the measure of such line, surface, or solid, respectively.

---

* As Arithmetic teaches the knowledge of whatever can be expressed in numbers, Geometry teaches the knowledge of whatever is extended and can be expressed in form and shape. The truths of Geometry are founded upon *definitions*, each furnishing a notion of the thing defined and the groundwork of the conclusions respecting it.

A *proposition* is a general term implying whatever is proposed to be effected, either in reasoning, or by drawing lines, angles, &c., or by both. It may either be a problem or a theorem.

A *problem* is something proposed to be done, and requires construction.

A *theorem* is a truth stated, and requires proof, or demonstration.

The various kinds of magnitude which admit of measurement, may be considered under the three following heads, namely:—

I. Mensuration of Lines and Angles.
II. Mensuration of Superficies.
III. Mensuration of Solids.

## PART I.—MENSURATION OF LINES AND ANGLES.

LINES are either straight or curved. When considered in connexion with other lines, they are either perpendicular, parallel, or angular. The mensuration of lines is nothing more than the means of ascertaining distances by lineal measure.* When a line is accessible all the way, it is readily measured by means of a chain or a measuring-rule, rod, or tape, divided into inches, feet, &c.; or by the *perambulator*. When the length is short, and it is

---

A *corollary* is a property which evidently results from the demonstration of a proposition.

An *axiom* is a self-evident truth, of which the following are some of the most frequent recurrence in geometrical propositions:—

AXIOMS.

1. Magnitudes which are equal to the same are equal to one another.
2. If equals be added to equals the sums will be equal.
3. If equals be taken from equals the remainders will be equal.
4. The doubles of the same or equal magnitudes are equal.
5. The halves of the same or equal magnitudes are equal.
6. The whole is greater than its parts.
7. Magnitudes which coincide with one another, or exactly fill the same space, are equal.

* See the Table of Lineal Measure, *ante.*, page 56.

necessary to be laid down on paper, a plain scale or diagonal scale * is used for that purpose. Lines which, on account of their position or other circumstances, are inaccessible, are reduced to the determination of angles, and measured by the quadrant, theodolite, telescope, &c.

When a line is mentioned simply, it means a straight line.

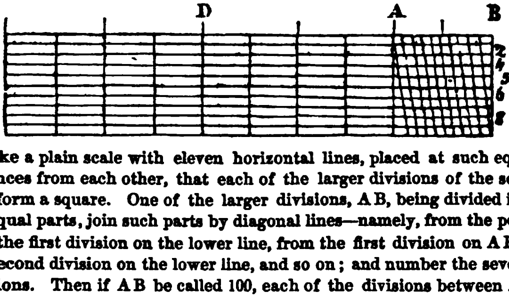
---

* Plain and diagonal scales are of extensive use in the accurate construction of geometrical figures, and are usually laid down on the rules contained in a case of instruments. They may be constructed on paper as follows:—

### TO MAKE A SCALE OF EVEN PARTS.

Make any very short distance between the points of a pair of compasses, and repeat it ten times along a straight line; take the length of ten divisions, and repeat it along the line as often as may be necessary, and a scale of even parts will thus be formed. By means of this scale, the lengths of lines may be compared with each other.

### TO MAKE A DIAGONAL SCALE.



Make a plain scale with eleven horizontal lines, placed at such equal distances from each other, that each of the larger divisions of the scale may form a square. One of the larger divisions, A B, being divided into ten equal parts, join such parts by diagonal lines—namely, from the point A to the first division on the lower line, from the first division on A B to the second division on the lower line, and so on; and number the several divisions. Then if A B be called 100, each of the divisions between A B will be 10, and the first distance between the perpendicular and diverging line below A, will be $\frac{1}{10}$th of 10, or 1; between the next two divisions, 2, &c. If A B be called 10, each of the divisions between A and B will be equal to 1, and the distances between the adjacent lines below A, $\frac{1}{10}$th, $\frac{2}{10}$ths, &c. If A B be called 1, then each of the divisions between A B will be $\frac{1}{10}$th, and the distances between the lines below A, $\frac{1}{100}$th, $\frac{2}{100}$th, &c.; hence, this scale is equally adapted for representing and comparing numbers by lines, whether these numbers be integers, decimals, or whole numbers and decimals. For delineating figures of different sizes, two of such scales, graduated at different distances, are usually marked on the same ruler.—*Ritchie's Geometry.*

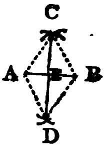
## 1. *Of Right Lines.*

A **Right Line*** is that which lies evenly between two points, and between which it is the shortest distance. It can be exhibited by stretching a hair between two points; as A B.

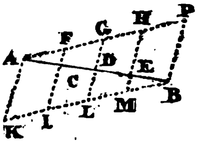
---

* PROBLEMS RELATING TO RIGHT LINES.

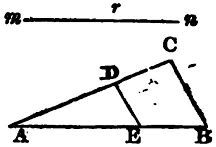
1. *To divide a line into two equal parts.*—From the points A and B, with any radius or opening of a pair of compasses greater than half of A B, describe two arcs, cutting each other in C and D; draw C D, and it will cut A B in the point E, making A E equal to E B.



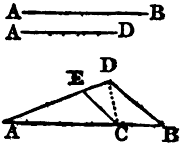
2. *To divide a line into any number of equal parts.*—From the ends A and B of the given line, draw two lines, A P and B K, of any length, parallel to each other (see page 66); then set off any number of equal parts from A towards P, and likewise from B towards K; draw lines between the corresponding points H M, G L, F I, &c., and they will divide A B into equal parts, as required.



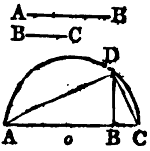
3. *To divide a line into two parts equal to two parts of another line.*—From A draw any line A C, equal to *m n*. and upon it transfer the divisions of the line *m n*—namely, *m r* and *r n*; join B C, and parallel to it, draw D E; then A E : E B :: *m r* : *r n*.



4. *To find a third proportional to two given lines.*—Place the two given lines, A B and A D, so as to make any angle with each other at A; from A B, the greater, cut off a part, A C, equal to A D, the less; join B D, and draw C E parallel to it; then will A E be the third proportional required, namely, A B : A D :: A D : A E.

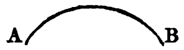


5. *To find a mean proportional between two given lines.*—Join A B and B C in one straight line—namely, make A C equal to the sum of them, and bisect it in the point *o*; with the centre *o*, and the radius *o* A, describe a semicircle; at B erect the perpendicular B D, and it will be the mean proportional required—namely, A B : B D :: B D : B C.—*Keith's Measurer.*



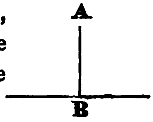
## 2. *Of Curved Lines.*

A **Curved Line** continually changes its direction between its extreme points; as A B. Curves are of an infinite variety of kinds; but only one of them (the circle, hereafter to be explained) falls within the limits of elementary geometry.



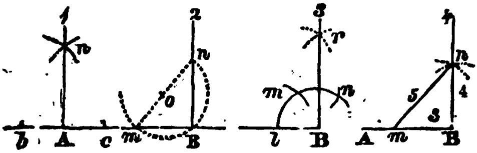
## 3. *Of Perpendicular Lines.*

A **Perpendicular Line*** is one which, meeting another line, does not incline more towards one end thereof than towards the other; as A B.



---

* TO DRAW A PERPENDICULAR UPON A GIVEN LINE.



1. On each side of the point A, take equal distances, as *b* A and A *c*; from *b* and *c* as centres, with any radius greater than *b* A or *c* A, describe arcs cutting each other in *n*; then will a line drawn from the point A, through *n*, be the perpendicular required.

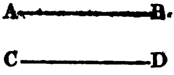
2. With any radius, from the point *o* as a centre, describe the arc *m* B *n*, cutting the line in *m* and B; draw a line from the point *m* through the centre *o* to *n*; then a line drawn through the point *n* to B, is the perpendicular required.

3. On the point B as a centre, with any radius, describe the arc *l m n*, cutting the line in *l*; with the same radius, and *l* as a centre, cut the arc in *m*; and with *m* as a centre, cut it in *n*; then from *m* and *n* as centres, describe arcs cutting each other in *r*; then a line drawn from B through *r*, will be the perpendicular required.

4. From the point B, on the line A B, take three equal parts (as feet, inches, &c.) to *m*; and from *m* and B as centres, describe arcs cutting each other in *n*, making the distance from B to *n* four parts, and from *m* to *n* five parts; then will the line B *n* be the perpendicular required. —*Templeton's Engineer.*

When the measurement is upon a large scale, the last rule will be found the most practicable, unless a cross-staff or theodolite can be brought into action. A perpendicular, or vertical line, from an horizontal surface which is perfectly level, may be found by means of a plumb-line.

## 4. *Of Parallel Lines.*



PARALLELS* are straight lines in a plane, which never meet, though extended ever so far both ways; as A B, C D.

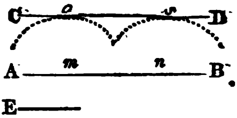
---

* THEOREMS RELATING TO PARALLEL LINES.

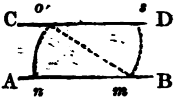
1. Parallel straight lines are everywhere equally distant.

2. Straight lines which are parallel to the same straight line, are parallel to each other.—*Euc.* i. 30.

PROBLEMS.



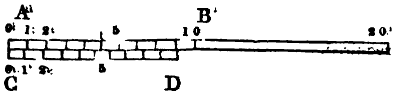
1. *To draw a parallel line at a given distance.*—From any two points *m*, *n*, in the line A B, with the extent of E in the compasses, describe two arcs, *o*, *s*; then draw the line C D, touching those arcs without cutting them, and it will be the parallel required.



2. *To draw a parallel line through a given point.*—Let *o* be the given point, and take any point *m* in the line A B; with *m* as a centre, and distance *m o*, describe the arc *o n*; with *o* as a centre, and the same distance, describe the arc *s m*; take the arc *o n* in your compasses, and apply it from *m* to *s*; through *o s* draw C D, and it will be the parallel required.

THE VERNIER, OR NONIUS.

The vernier, or Nonius, (so called after the name of its supposed inventor,) is an ingenious and useful application of the property of parallels to the finding small portions of a line, and is constructed as follows :—

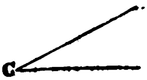


Suppose an inch, A B, divided into 10 equal parts, each part will be $\frac{1}{10}$ of an inch. Again, suppose a line equal to 9 of these parts be also divided into 10 equal parts, each of these will be $\frac{1}{10}$ of $\frac{9}{10}$ of an inch, which is $\frac{9}{100}$. But the length of the first division being $\frac{1}{10}$, or $\frac{1}{100}$, and that of the second $\frac{9}{100}$, one of the first divisions is $\frac{1}{100}$ of an inch longer than one of the second. If the line C D slide along parallel to A B, till the two divisions marked 1, 1, form a continuous line, the sliding scale will have moved $\frac{1}{100}$ part of an inch towards B; if it slide along till the next two divisions coincide, it will have moved $\frac{2}{100}$ of an inch, &c.—*Ritchie's Geometry.*

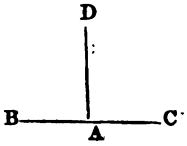
The theory of parallels is of the highest importance in mathematics, being an essential element of most demonstrations.

## 5. *Of Angles.*

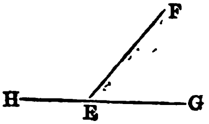
An angle[*] is formed by the inclination of two right lines meeting each other in a point; as C.



When a line is perpendicular to another, making the angles on both sides equal, such angles are called right angles; as B A D, C A D.



When the angle is not a right angle, it is oblique; and if greater than a right angle, it is called an obtuse angle; as F E H; when less, it is an acute angle; as F E G.

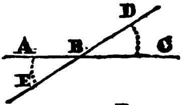


In order to measure an angle, a circle is considered to have its centre at the *vertex*, or point where both the sides of the angle meet. Every such circle is considered to be divided into 360 parts, called degrees; each degree, into 60 minutes; and each minute, into 60 seconds; and the size of the angle is calculated according to the number of such degrees, &c., cut off from the circle by the lines.

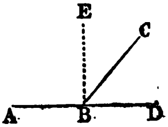
---

[*] AXIOMS AND THEOREMS RELATING TO ANGLES.

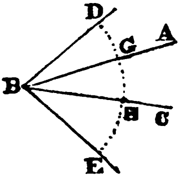
1. All right angles are equal to one another.
2. Angles that have equal measures, or arcs, are equal.
3. When two lines intersect each other, the opposite angles are equal; for the angles E B A and A B D are together equal to two right angles, and the angles C B D and A B D are also equal to two right angles; therefore the angle E B A is equal to the angle C B D.

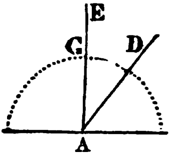


4. When one line meets another, the angles which it makes on the same side of the line are together equal to two right angles. Thus, A B C and C B D (both formed by the lines A D and B C) are equal to two right angles.



which form the angle. The magnitude of an angle, therefore, does not depend upon the length of the lines by which it is contained, but upon the opening between such lines, that is, the extent, calculated in degrees, &c., to which the branches are separated the one from the other. Thus, the angle A B C being measured by the arc G H, is less than the angle D B E, though the lines A B and C B, which make the former angle, are longer than the lines D B and B E, which form the latter. A right angle is equal to 90 degrees, and four right angles are equal to the whole circle; an acute angle is less than 90 degrees; an obtuse angle is greater than 90 degrees; all the angles that can be made on the same side of a straight line, are together equal only to two right angles, or 180 degrees. Hence, angles may be compared with each other by comparing the number of degrees contained in the intercepted arcs of a circle described from the angular point as a centre. Thus, if the arc D E contains 80, and D G 20 degrees, the angle E B D will be four times the angle A B D.

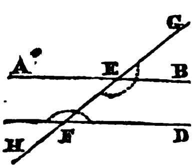




---

5. When a line intersects two parallel lines, it makes the alternate angles equal to each other. Thus, the angle A E F is equal to the alternate angle E F D.

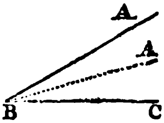
6. When a line cuts two parallel lines, the outward angle is equal to the inward opposite one on the same side; and the two inward angles on the same side, are together equal to two right angles. Thus, the outward angle G E B will be equal to the inward opposite angle E F D; and the two inward angles B E F and E F D, taken together, will be equal to two right angles.



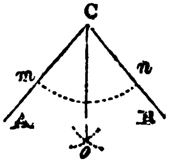
When an angle is expressed by three letters, the middle letter always stands at the angular point. When there is only one angle, it may be named by the letter placed at the angular point.

### PROBLEMS.

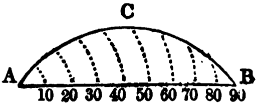
1. *To describe, enlarge, or diminish an angle.*—Take two lines, A B and B C, meeting each other in the point B; conceive these two lines to open like the legs of a pair of compasses, so as always to remain fixed to each other in B. While the extremity A moves from the extremity C, the greater is the opening, or angle A B C; and, on the contrary, the nearer you bring them together, the less the opening, or angle, will be.



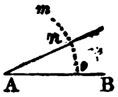
2. *To bisect an angle.*—From the centre C, with any radius, describe an arc *m n*; from *m* and *n*, as centres, with the same radius, describe two arcs crossing each other in *o*; draw C *o*, and it will divide the given angle A C B into the two equal angles A C *o* and B C *o*.



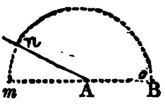
3. *To draw a line of chords.*—Let the arc A C B be a quadrant, or quarter of a circle; divide it into 90 parts, or degrees, and draw straight lines from A to each division; we shall thus have chords of all arcs from 1 degree to 90. Then on A as a centre, with the compasses, transfer these divisions to the chord line A B, which mark with the corresponding numbers, and it will become a line of chords.



4. *To make an angle of 30 degrees by the scale of chords.*—Take the extent of 60 degrees from the line of chords, with which, from the centre A, describe the arc *o m*; take 30 degrees from the same line, and set them off from *o* to *n*; through *n* draw A *n*; then *n* A B is the angle required.



5. *To make an angle of* 150 *degrees.*—Produce the line B A to *m*; with the centre A, and the chord of 60 degrees, describe the semicircle *o n m*; take the given obtuse angle from 180 degrees, and set off the remainder—namely, 30 degrees—from *m* to *n*; then *n* A B is the angle required.



## PART II.—MENSURATION OF SUPERFICIES.

A SURFACE, or superficies, has two dimensions, length and breadth.

A *plane*, or *plane surface*, is that which is everywhere flat and even, or which will touch every part of a straight line, in whatever direction it may be laid upon it.

A *curved surface* is that which will not coincide with a straight line in any part; and such curved surface may either be convex (that is, rising up) or concave (that is, hollow).

A superficies may be contained within one curved line, but cannot be contained in fewer than three straight lines.

The figures which are usually the subject of Mensuration of Superficies, are either *rectilinear* (that is, such as are bounded by straight lines only, including triangles, or three-sided figures, quadrilaterals, or four-sided figures, and polygons,) or *curved* (that is, such as are bounded by curved lines, including the circle and its segments and sectors, the ellipsis, the parabola, and the hyperbola).*

The *base* of a figure is the side on which it is supposed to stand erect.

The *altitude* of a figure is the perpendicular height from the base to the highest part.

The Mensuration of a plane figure, or other surface, consists in ascertaining the quantity of space contained within its boundaries, technically called, finding its *area*.

---

* THEOREMS APPLICABLE TO SUPERFICIES GENERALLY.

1. All similar figures are to each other as the squares of their homologous or like sides. (See the theorems relating to triangles, quadrilaterals, &c., *infra.*)

2. Similar figures described in circles are to each other as the squares of the diameters of those circles. (See the theorems relating to the circle, &c., *infra.*)

This area is computed from another space of a determinate form and magnitude—that is, from a square, whose side is one inch, one foot, &c., called the *measuring-unit.* The dimensions are taken in lineal measure, usually in inches and parts of an inch, (as tenths or eighths,) and are reduced to square inches, square feet, &c., according to the nature of the thing measured; and the number of such square inches, feet, &c., contained in the figure, is called the area of the figure.

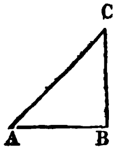
The area of a superficies, properly speaking, is the magnitude of its surface, without regard to depth or thickness; but as most plane surfaces are measured with reference to some solid body of which they form a part, it is usual, in excise calculations, to take the dimensions as if they were one inch deep, because the divisors for reducing them to gallons or bushels are in this denomination. This is in anticipation of the mensuration of solids, for the inches thus taken are, in fact, solid or cubic inches; but this mode of calculation materially facilitates the reduction of the area into the proper number of gallons, bushels, &c., contained in any utensil of which the plane figure may form a part. When, therefore, the area of any figure is mentioned, it will be understood to signify the content in cubic inches, unless otherwise expressed.

After the area has been found in inches, it may be reduced into bushels or gallons either by dividing it by 2218·192, or 277·274, the number of square inches contained in a bushel and gallon respectively; or by multiplying it by ·000451 or ·003607, the proper factors for bushels and gallons respectively.*

---

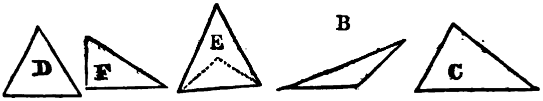
* *Vide ante.*, pages 31, 32. See, also, the Tables for reducing Cubic Inches into Pounds' Weight, Gallons, and Bushels, respectively, pages 51, 53, 55.

## 1. *Of Triangles.*



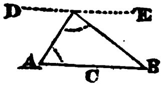
A TRIANGLE is a figure, or superficies, bounded by three right lines. It is formed by a line connecting the legs or extremities of an angle, and has, therefore, three sides and three angles. If all the lines be equal, it is called an *equilateral* triangle; as D. If two of the lines be equal, it is called an *isosceles* triangle; as E. If all the sides be unequal, it is said to be a *scalene* triangle; as F. A triangle is right-angled, as A B C, when two of the sides are perpendicular to each other; and it is obtuse-angled, as B, or acute-angled, as C, according as it has one of its angles obtuse, or all of them acute.

In a right-angled triangle, as A B C, the lower line, A B, is usually called the *base;* the upright line, as B C, the *perpendicular;* and the other line, as A C, the *hypothenuse.*



### THEOREMS, &C., RELATING TO TRIANGLES.

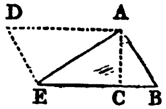
The following are some of the properties of triangles upon which are founded many of the calculations in Mensuration, as well superficial as solids.



1. The sum of the angles of every triangle is equal to two right angles, or 180 degrees.

2. The sum of any two sides of a triangle are greater than its third side; and the difference of any two sides of a triangle is less than the third.

3. The greater side of every triangle lies opposite the greater angle, and *vice versa.*

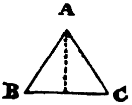


4. Every triangle is equal to half a parallelogram of the same base and altitude.

5. If one angle of a triangle be a right angle, the sum of the other two will also be equal to a right angle; and each of them singly will be acute, or less than a right angle.

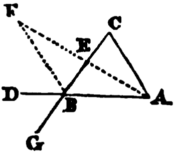
The triangle is the most important figure in Geometry, and its various lines bear the most interesting relations to each other. Its three angles are always equal to two right angles; its sides are proportional to the sines of their opposite angles; and the sides of different triangles having equal angles, are proportional to each other. The triangle is

---



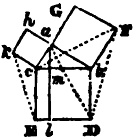
6. In an isosceles triangle, the angles at the base are equal; or, if a triangle have two sides equal, their opposite angles will also be equal.

7. When a triangle has two of its angles equal, the sides opposite to them are equal.



8. If one side of a triangle be produced, the outward angle will be greater than either of the two inward opposite angles.

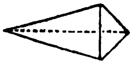
9. If one side of a triangle be produced, the outward angle is equal to both the two inward opposite angles taken together.



10. The square described on the hypotenuse, or side opposite the right angle of a right-angled triangle, is equal to the sum of the squares described on the other two sides: thus, if *b a c* be the right-angled triangle, right-angled at *a*, and *b* G, *c h*, and *c* D the squares described on its sides, then the square *c* D will be equal to the squares *b* G and *c h*. This is one of the most important properties of the triangle.

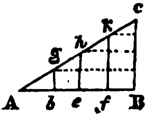
11. The side of a square inscribed in a triangle, equals the product of the base and altitude divided by their sum.

12. If two triangles have two sides of the one respectively equal to two sides of the other, and the angles contained between those sides equal, the triangles will be equal in every respect.



13. If two triangles have all the sides of the one respectively equal to all the sides of the other, they are equal in every respect.

14. If two triangles have a side of the one equal to a side of the other, and the angles at the extremities of those sides equal, the triangles will be equal in every respect.

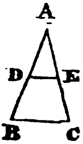


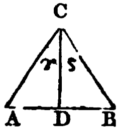
15. The segments into which diverging lines are cut by parallels being proportional to one another, triangles between the same parallels are to one another as their bases. Let A C be divided into any number of equal parts, and let C B be joined, and the lines *k f*, *h e*, and *g b* be drawn parallel to B C, then A *b* : A *g* :: A *e* : A *h*, and A *f* : A *k* :: A B : A C.

easily measured; and as all figures may be reduced to triangles, the principle on which this measurement is founded, (namely, Trigonometry,*) is applied to most of the problems in Astronomy, Geography, and Surveying.†

---

16. Triangles, when their bases are equal, are to each other as their altitudes; and when their altitudes are equal, they are to each other as their bases: therefore, universally, when neither are equal, they are to each other in the compound ratio, or as the rectangle or product of their bases and altitudes. Let D E be parallel to the side B C of the triangle A B C, then will A D : D B : : A E : E C. A B : A C : : A D : A E; and A B : A C : : B D : C E. Let the angle A C B, of the triangle A B C, be bisected by the line C D, making the angle *r* equal to the angle *s*; then will the segment A D be to the segment D B, as the side A C is to the side C B; or, A D : D B : : A C : C B.



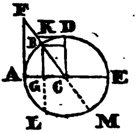


17. The areas of similar triangles are to one another as the squares of their corresponding sides.

18. If two triangles have an angle of the one equal to an angle of the other, their areas are to one another as the product of the sides containing that angle.

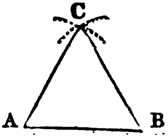
### * TRIGONOMETRY.

Trigonometry is the method of determining the sides and angles of triangles. It has been seen (page 68) that angles are measured by the arcs of a circle which they include; and as all triangles which have equal angles have all their sides equal in proportion, it is easy to infer that the angle at the centre of a circle has the same ratio to four right angles that the arc intercepted between the lines which contain the angle has to the whole circumference of the circle. Upon this principle, the quadrant of a circle with a very large radius has been minutely divided, and the different angles connected with each such minute division calculated and reduced to tables; so that other angles bearing the same relation to the area of any other circle, may be determined by proportion. It will only be necessary here to refer to the particular lines of the circle on which these calculations are made. A E is the diameter; C D is the radius; B G is the sine; C G is the co-sine; or C A is the radius; A F is the tangent, and C F is the secant.



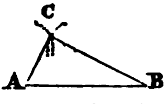
### † PROBLEMS RELATING TO TRIANGLES.

1. *To describe an equilateral triangle on a given line.*—With B as a centre, and radius equal to A B, describe an arc; with A as a centre, and distance A B, cross it in C; draw A C and B C; then will A B C be the equilateral triangle required.



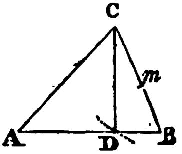
TO FIND THE AREA. RULE I.—Multiply the base by the perpendicular height, and half the product will be

---

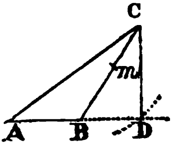


2. *To make a triangle from three given lines.*—With A as a centre, and radius A C, describe an arc; with the centre B, and distance B C, cross it in C; draw A C and B C; then A B C is the triangle required.

3. *To make a triangle from two given sides and one given angle, or two given angles and one given side.*—If two sides are given, set off the angle from the line of chords, and the two given lines from the scale of equal parts (see page 63); join the two given lines, and it will produce the triangle required. If two angles and one side are given, measure the length of the given line by the scale, and set off an angle at each end by the line of chords. (See fig. to Theorem 1.)



4. *To find the perpendicular of a triangle.* BY CONSTRUCTION.—Bisect either of the sides containing the angle from which the perpendicular is to be drawn, as B C, in *m*; with the radius *m* B, and centre *m*, describe an arc cutting A B (produced if necessary) in D; draw C D, and it will be the perpendicular required.



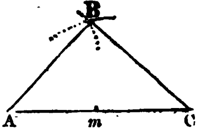
BY CALCULATION.—1st. Add the square of the base to the difference of the squares of the two sides; the sum, divided by twice the base, will give the greater segment; and this, subtracted from the whole base, will give the less segment. 2nd. From the square of the greater of the two sides subtract the square of the greater segment, or from the square of the less side subtract the square of the less segment; the square root of the result will be the perpendicular sought.

The perpendicular height of an equilateral triangle may be found by multiplying the base by ·866, or, more correctly, by ·8660254.

5. *Two sides of a right-angled triangle being given, to find the third side.*—Multiply the sum of the hypotenuse and one side by their difference, the square root of the product will give the other side.

6. *To find the hypotenuse of a right-angled triangle, two sides being given.* BY CONSTRUCTION.—From the point B, in A B, (see fig. 1, page 72,) draw B C perpendicularly; set off the given lengths on A B and B C; join A C, and it will be the hypotenuse required.

BY CALCULATION.—To the square of the base add the square of the perpendicular; the square root of the sum will give the hypotenuse required.



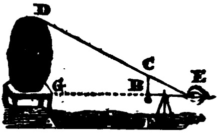
7. *The hypotenuse and one side of a triangle being given, to find the other side.*—Bisect A C in *m*; with *m* as a centre, and the distance *m* A, describe an arc; with A as a centre, and distance A B, cross it in B; then A B C is a right-angled triangle, and B C is the required side.

the area. Or multiply the base by half the perpendicular, or the perpendicular by half the base; the product, in either case, will be the area.*

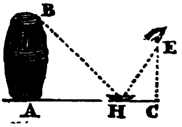
RULE II.—If the perpendicular is not known, subtract each side separately from half the sum of the three sides;

---

8. *To find the height of a perpendicular object by means of two rods placed at right angles to one another.*—Let E B and B C be two straight rods forming a right angle at B; place them on a stick or stand with three feet, at F, so that the eye may be conveniently applied at E. Place C B perpendicularly, by means of a plumb-line hung from C; if it be so placed that the top of the object, D, be seen in the same straight line with E and C, and if the distance E G be measured, we have E B : B C : : E G : G D, which, being increased by the height of the eye, (that is, by A G,) will give the height of the object.



9. *To find the height of a perpendicular object by means of an artificial horizon.*—Place any substance capable of reflecting light uniformly (as the surface of mercury, ink, soft treacle, &c.) at H, and the eye at E, so that the top of the object may be seen by reflection in H. Measure the height of the eye, C E, and the distances C H and H A; then C H : C E : : A H : A B.

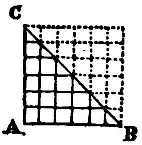


10. *To find the height of a perpendicular object by means of its shadow.*—As the shadow of a perpendicular stick is to the height of the stick, so is the shadow of the object to the height of the object. (See *Ritchie's Geometry.*

* EXAMPLES APPLICABLE TO RULE I.

(1.) Required the area of a triangle A B C, the base A B being 6 inches, and the perpendicular A C being also 6 inches.

Inches.
Perpendicular A C 6
Base A B ........ 6
½ ) 36
Area 18 inches.

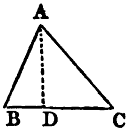


The triangle is here obviously the half a square, the whole of which would cut into 36 square inches, supposing each of the small squares to represent one square inch; half of this, therefore, constitutes the area of he triangle. (See page 17.)

multiply the half-sum and the three remainders continually together, and the square root of the last product will be the area.*

---

(2.) Required the area of a triangle A B C, the base B C being 60 inches, and the perpendicular A D being 23·5 inches.



23·5 (perpen.) × 30 (½ base) = 705 inches. Ans.

(3.) Required the area of a triangle, the base being 396, and the perpendicular 174.

396 × 87 = 34452. Ans.

If the area of a triangle be divided by half the perpendicular height, the quotient will be the base.

If the area be divided by half the base, the quotient will be the perpendicular height.

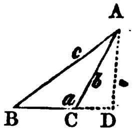
This rule is deduced from the following geometrical theorem :—The area of a triangle is a mean proportional between two rectangles, one of which is contained by half the perimeter or limits of the triangle, and the excess of half the perimeter above any one of its sides; and the other is contained by the excesses of half the perimeter above each of the other two sides.

* EXAMPLES APPLICABLE TO RULE II.

(4.) Let A B C be a triangle, whereof the sides A B = 40, A C = 28, and B C = 32, required the area.

$$\tfrac{1}{2}(A\,C + A\,B + B\,C) = \tfrac{1}{2}(40 + 28 + 32) = 50.$$

$$\left.\begin{array}{l}50 - 28 = 22\\ 50 - 32 = 18\\ 50 - 40 = 10\end{array}\right\}\text{The three remainders.}$$



Then, 50 × 22 × 18 × 10 = 198000, whereof the square root is 445 square inches nearly, the area required.

If the triangle be equilateral the area will be found by multiplying one-fourth the square of a side by the square root of 3 ; or, which is the same thing, by multiplying the square of a side by ·433, or, more correctly, by ·4330127.

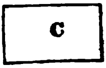
Conversely, if the area of an equilateral triangle be given to find its side, divide the given area by ·433; the square root of the quotient is the side required.

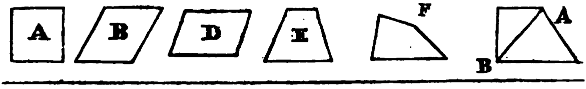
If the triangle be an isosceles, the area may be found by multiplying the sum of one of the equal sides and half the third side by their difference, and the square root of the product by half the third side; the result will be the area.

This mode of finding the area of a triangle is useful where only the sides are given and the triangles are acute-angled, isosceles, and scalene; it is also used in determining the area of a trapezium from the four sides and one of the diagonals; but wherever the perpendicular can be measured or easily found, it is better to act upon the first rule.

## 2. *Of Quadrilaterals.*

A QUADRILATERAL,* or quadrangle, is a superficies bounded by four straight lines. If the opposite sides be parallel, it is called a *parallelogram.* A right-angled parallelogram, having all its sides equal, is a *square;* as A. A right-angled parallelogram having only its opposite sides equal, is a *rectangle;* as C. If all the sides of a parallelogram be equal, but its angles not right angles, it is a *rhombus* (sometimes called a *lozenge*); as B. If the opposite sides only of a parallelogram be equal, and the angles not right angles, it is a *rhomboid;* as D. All other quadrilaterals are *trapezoids* or *trapeziums.* A trapezoid has two of its sides parallel, but not equal; as E. A trapezium has none of its sides parallel; as F.





---

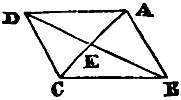
* THEOREMS RELATING TO QUADRILATERALS.

1. In any quadrangle, the sum of all the four inward angles is equal to four right angles.

2. The opposite sides and angles of any parallelogram are equal to each other.

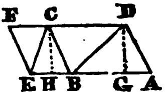
3. If one angle of a parallelogram be a right angle, all the other three will also be right angles, and the parallelogram is a square or rectangle.

4. The sum of any two adjacent angles of a parallelogram is equal to two right angles.



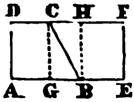
5. The sum of the squares of the two diagonals of a parallelogram is equal to the sum of the squares of all the four sides of the parallelogram.

6. Parallelograms having the same base and altitude, or equal bases and altitudes, are equal.



7. The areas of parallelograms having the same altitudes are as their bases. Thus, A B C D : B E F C :: A B × D G : B E × D G :: A B : B E.

8. A trapezoid is equal in area to the product of its altitude by half the sum of its parallel sides.

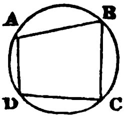


The square, on account of its perfect regularity, is of great importance, both in pure and applied mathematics; and it is the form to which, in the measurement of surfaces all other forms are reduced, all areas being calculated according to the number of squares (as square inches, square feet, &c.) which the surface contains.

A line connecting two opposite angles of a quadrilateral figure, divides such figure into two triangles, and is called a *diagonal;* as A B.

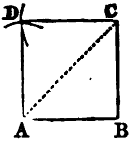
---

9. In any quadrilateral figure inscribed in a circle, the sum of the two opposite angles is equal to two right angles.



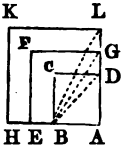
### PROBLEMS.

1. *To describe a square upon a given line.*—Raise A D and B C each perpendicular and equal to A B, and join D C; A B C D will then be the square required.

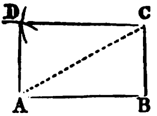


2. *To find the diagonal of a square.*—Take the square root of twice the square of the sides; or, which is the same thing, the square root of twice the area; or else multiply 1·4142136 (which is the square root of 2) by the side; the product will be the diagonal.

3. *To find the side of a square that shall be any number of times the area of a given square.*—Let A B C D be the given square, then will the diagonal B D be the side of a square A E F G, double in area to the given square A B C D; and if the diagonal be drawn from B to G, it will be the side of a square A H K L, three times the area of the square A B C D; or the diagonal B L will be equal to the side of a square four times the area of the square A B C D.

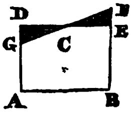


4. *To describe a rectangle of a given length and breadth.*—Erect A D and B C perpendicular to A B; let A B be equal to the given length, and A D and B C each equal to the given breadth; join D C, and it is done.



5. *To find the diagonal of a rectangle.*—Extract the square root of the sum of the squares of any two adjacent sides; the root will be the diagonal.

6. *To convert a trapezoid into a parallelogram.*—Let A B F G be a trapezoid. Bisect F G in C, and through C draw D E parallel to A B, meeting A G produced in D; then the parallelogram A E will be equal to the trapezoid; for the triangle D C G is equal to the triangle E C F.



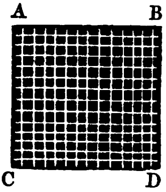
I. TO FIND THE AREA OF A PARALLELOGRAM.—Multiply the length by the breadth, or perpendicular height, and the product is the area.*

II. TO FIND THE AREA OF A TRAPEZOID.—Multiply the sum of the two parallel sides by the perpendi-

---

* EXAMPLES APPLICABLE TO RULE I.

(1.) Let the side of the square A B D C be 14 inches, what is the area?



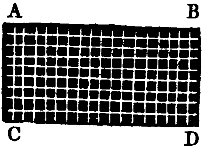
| | Inches. |
|---|---|
| A B | 14 |
| A C | 14 |
| | 196 Area. |

This operation is simply the converse of extracting the square root, as explained in page 17; therefore, as the area is found by squaring the side, so, conversely, the side is found by extracting the square root of the area.

(2.) What is the area of a square whose side is 40 inches?

$40 \times 40 = 1600$ inches. Ans.

(3.) What is the area of a rectangle, the length A B being 18 inches, and breadth B D 9 inches? $18 \times 9 = 162$ inches. Ans.

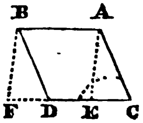


The same result is obtained by finding a mean proportional between the length and breadth, and then squaring it. This process is easily performed on the sliding-rule, as will be more fully explained in the proper place.

The areas of rectangles and similar figures are frequently required to be found at once in gallons or bushels, and several expeditious methods have been suggested for this purpose. One of these is a Table of Semi-squares, (calculated by Mr. Todd, excise officer, and published at the Government press,) which is used something like a Table of Logarithms, addition and subtraction being substituted for multiplication and division. (See the section on Prisms, and the Table on Semi-squares, &c., *infra.*)

If the area of a rectangle be divided by one of its sides, the quotient will be the adjacent side.

(4.) Let the sides of the rhombus A B D C = 40 inches = A B = B D, and the perpendicular B F 37 inches, what is its area? $40 \times 37 = 1480$. Ans.



The perpendicular breadth of any parallelogram will be found by dividing the area by the length; and the length will be found by dividing the area by the breadth. To find the diagonals, the angles must be known, and the operation will require Plane Trigonometry.

cular distance between them, and half the product will be the area.*

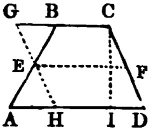
III. To FIND THE AREA OF A TRAPEZIUM.—Multiply the sum of the two perpendiculars by the diagonal upon which they fall, and half the product will be the area.†

---

* EXAMPLE APPLICABLE TO RULE II.

(5.) Let A B C D be a trapezoid, one of the parallel sides being 40, and the other 30, and the perpendicular distance between them 102, what is the area?

A D + B C = 40 + 30 = 70 Sum.
C I 102
2) 7140
3570 Ans.



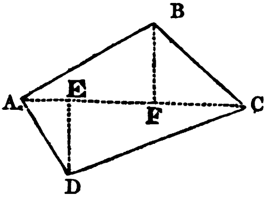
The reason for this rule will appear from the construction of the figure (and see theorem 8). The same result would be obtained by changing the trapezoid into a parallelogram, as in problem 7, and operating by Rule I.

If the area of the trapezoid and the sum of the parallel sides be given, the perpendicular distance between them will be found by dividing the area by half the given sum.

† EXAMPLE APPLICABLE TO RULE III.

(6.) Let A B C D represent a trapezium whose diagonal, A C, is 60 inches, the perpendicular B F 15 inches, and the perpendicular D E 27 inches; required its area.

Inches.
B F 15
D E 27
42 Sum.
A C 60
2) 2520
1260 Ans.



The reason of this rule is sufficiently obvious; it is, in effect, the same as if the trapezium were divided into two triangles, and the area of each triangle found and calculated together.

If the trapezium can be inscribed in a circle, the sum of its opposite angles will be equal to two right angles, and its area may be found by adding the four sides together, and from half the sum subtracting each side separately; the square root of the product of the four remainders will give the area of the trapezium. (For the mode of measuring figures by equidistant ordinates, see section 6, *infra.*)

## 3. *Of Polygons.*

PLANE figures having more than four sides, are generally called *polygons*,* and receive their particular denominations from the number of their sides or angles.

A *pentagon* is a polygon of five sides; an *hexagon*, of six; an *heptagon*, of seven; an *octagon*, of eight; a *nonagon*, of nine; a *decagon*, of ten; an *undecagon*, of eleven; and a *duodecagon*, of twelve.

A regular polygon has all its sides and angles equal; when they are unequal, the polygon is irregular.

---

* THEOREMS RELATING TO POLYGONS.

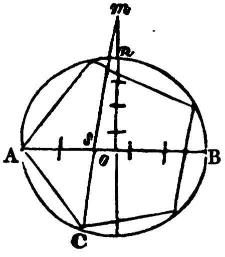
1. The sum of all the interior angles of any rectilineal figure is equal to twice as many right angles as the figure has sides diminished by four right angles.

2. When every side of any figure is produced out, the sum of all the outward angles thereby made is equal to four right angles.

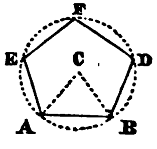
3. Similar polygons described in circles are to each other as the circles in which they are described, or as the squares of the diameters of those circles.

PROBLEMS.

1. *To inscribe a regular polygon in a given circle.*—Divide the diameter A B into as many equal parts as the figure is to have sides; extend the perpendicular *o m* beyond the circle three-fourths the extent of the radius *o n*; from *m*, through the second division of the diameter A B, draw *m* C; join A C, and it will be the side of the polygon required, or nearly so.



2. *To construct a pentagon with the line of chords.*—The sum of all the angles $= 2\times5-4 = 6$ right angles or 540 degrees, (see theorem 1); hence each angle contains 108 degrees. At A and B draw A C and B C, making with A B angles of 54 degrees (half 108); from C, with the distance A C describe a circle, then A B repeated along the circumference will obviously go five times exactly; for the angle A C B will contain 72 degrees, and, consequently, A B will be an arc of 72 degrees, which is the fifth of 360.



Any other regular polygon may be constructed in the same manner.

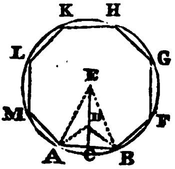
TO FIND THE AREA OF A REGULAR POLYGON.—I. Multiply the perimeter (or number of sides in the figure) by the perpendicular falling from the centre upon one of the sides, and half the product will be the area.*

II. If the perpendicular be not known, multiply the square of one side of the polygon by the area of a similar polygon the side of which is unity.†

---

3. *To construct an hexagon without the line of chords.*—On the line A B (see the figure below) describe the equilateral triangle A C B; from C, with the radius A B, describe a circle; then A B will go exactly six times round the circumference, and form a regular hexagon A B D E F G.

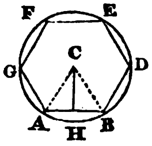
4. *To describe a regular octagon on a given line.* Bisect A B by the perpendicular C D; make C D equal to A C, and join A D; make D E equal to A D, and E will be the centre of a circle which will circumscribe the required octagon; repeat A B along the circumference, and AB F G H K L M will be the octagon required.



* EXAMPLE.

(1.) Let one of the sides of the hexagon A B D E F G be 72 inches, then the perpendicular C H will be 62·35; what is its area?

Inches.
72
6 sides.
432
62·35
2 ) 26935·20
13467·60 Ans.



Here it will be seen that half A B × C H = the area of the triangle A C B; and the figure contains as many such triangles as it has sides. This rule is, in effect, only resolving the polygon into as many triangles as it has sides, by supposing lines drawn from its centre to all its angles, and then taking the sum of their areas for the area of the figure.

† The area of a polygon of which the side is unity, or 1, may be found by constructing such a polygon with a side of one inch, and calculating the area according to Rule 1; or it may be demonstrated by Plane Trigonometry. Whence, as all regular polygons of the same number of sides are similar to each other, and as similar figures are as the squares of their like sides, (Euc. vi. 20,) the square of the side of any polygon multiplied by its area, when its side is unity, is equal to the area of the polygon.

III. TO FIND THE AREA OF AN IRREGULAR POLYGON.—Reduce the figure, by diagonals and perpendiculars, to as many regular figures (as squares, triangles, trapeziums, or trapezoids) as may be most convenient, and add the several areas together; and the sum will be the area of the whole figure.*

---

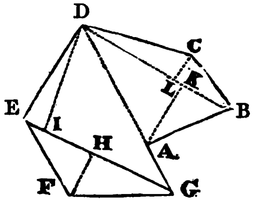
(See *Bonnycastle's Mensuration*, 55.) The area of a pentagon whose side is unity, is thus found to be 1·7204; of an hexagon, 2·598; of an heptagon, 3·6339; of an octagon, 4·8284, &c. (See the Table, *infra.*)

EXAMPLE APPLICABLE TO RULE II.

(2.) Let the area of the above hexagon be required.

A B (72) squared is 5184, which, multiplied by 2·598, (see the Table referred to above,) gives 13468·032 nearly, as before.

If, instead of finding the area in inches, it be desired to find it at once in bushels or gallons, it is only necessary to multiply the square of one side of the polygon by the proper factor, which may be found by dividing the respective areas referred to in the rule by 277·274 for gallons, and by 2218·192 for bushels. In this way is constructed the Table of Factors for finding the Areas of Regular Polygons, which will be found in a subsequent part of this work, the use of which will be seen by the foregoing rule and examples.



* EXAMPLE APPLICABLE TO RULE III.

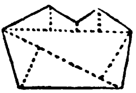
(3.) Required the area of the irregular figure A B C D E F G, the following lines being given :—

G E = 47 F H = 13·5 D I = 29·25
B D = 46 C L = 6·5 A K = 19·5

Here $(29{\cdot}25 + 13{\cdot}5) \times 47 = 42{\cdot}75 \times 47 = 2009{\cdot}25$ = twice trap. D E F G.
And $(19{\cdot}5 + 6{\cdot}5) \times 46 = 26 \times 46 = 1196$ = twice trap. A B C D.

2 ) 3205·25

1602·625 = area ABCDEFG.

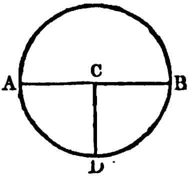


When any part of the figure is very irregular, or even bounded by a slight curve, it is usual, in surveying, to erect a number of perpendiculars, as in the annexed figure, adding the length of each together, and dividing the sum by their number for a mean breadth, and then multiplying such mean breadth by the length of the base. This will give the area of that part of the figure required, or nearly so. In excise calculations, however, irregular and doubtful curves, &c., are measured by equidistant ordinates. (See section 6, *infra.*)

## 4. *Of the Circle and its Sectors.*

A Circle[*] is a plane figure bounded by a curved line called the *circumference*, which is everywhere equidistant from a certain point within it, called the *centre*.

The *diameter* of a circle is a right line drawn through the centre and terminating in the circumference on each side; as A B. And any line drawn from the centre to the circumference, as C D, is called a *radius*.



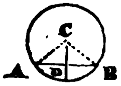
A *semicircle* is equal to one-half of a circle; as A D B; and a *quadrant* is equal to one-quarter of a circle, as A C D.

An *arc* of a circle is any part of the periphery or cir-

---

[*] THEOREMS RELATING TO CIRCLES, &c.

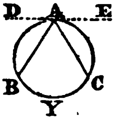
1. If a line drawn through or from the centre of a circle bisect a chord, it will be perpendicular to it; or, if it be perpendicular to the chord, it will bisect both the chord and the arc subtended by the chord.



2. Any chords in a circle which are equally distant from the centre, are equal to each other; or, if they be equal to each other, they will be equally distant from the centre.

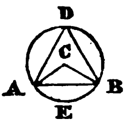
3. An angle at the circumference of a circle is measured by half the arc that subtends it.

4. The angle formed by a tangent and chord is measured by half the arc of that chord.



5. An angle at the centre of the circle, as C, is double an angle at the circumference, as D, when both stand on the same arc or chord.

6. Any two parallel chords in a circle intercept equal arcs.



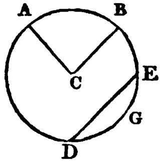
7. The area of a circle is equal to the area of a triangle whose base is equal to the circumference, and whose perpendicular is equal to the radius.

8. The area of a circle is equal to a rectangle contained under half its periphery and half its diameter.

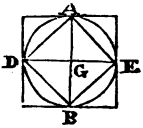
9. Any angle in a semicircle is a right angle.

10. All angles in the segment of a circle, or standing on the same arc, are equal to each other.

cumference. The *chord*, or subtense, of an arc, is a right line joining the two extremities of such arc, as D E, which is the chord of D G E, or of the arc E B A D. The figure which is contained by an arc and its chord, is called a *segment*; as D G E. And a figure contained by any arc and the radii drawn to its extremities, is called a *sector*; as A C B.



---



11. A square circumscribed about a circle, is equal to four times the square of the radius; and a square inscribed in a circle, to half the circumscribed, that is, to twice the square of the radius.

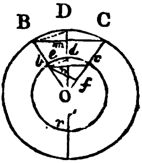
12. Similar figures inscribed in circles have their like sides, and also their whole perimeters, in the same ratio as the diameters of the circles in which they are inscribed.

13. Similar figures inscribed in circles are to each other as the squares of the diameters of those circles.

14. The circumferences of all circles are to each other as their diameters.

15. The areas or spaces of circles are to each other as the squares of their diameters or of their radii.

16. The versed-sines of similar segments are as the diameters of the circles to which they belong; and the areas of those segments, as the squares of the diameters.

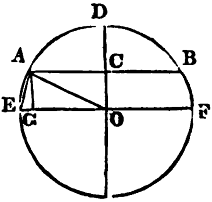


Let B D C B and $b\,d\,c\,b$ be any two similar segments, cut off from the similar sectors B D C O B and $b\,d\,c\,O\,b$, by the chords B C and $b\,c$; and let the perpendicular O D bisect them. Then, by similar triangles, $DB : db :: BO : bO$, and $DB : db :: Dm : dn$; whence, by equality, $BO : bO :: Dm : dn$, or $2BO : 2bO :: Dm : dn$.

Again, since similar segments are as the squares of their chords, it will be $CB^2 : cb^2 :$ seg. $CDBC ::$ seg. $cdbc$; but $CB^2 : cb^2 :: OB^2 : cb^2$, whence, by equality, seg. $CDBC :$ seg. $cdbc :: OB^2 : Ob^2$; or, seg. $CDBC :$ seg. $cdbc :: 4BO^2 : 4bO^2$.—*Bonnycastle's Mensuration;* and see *Moss's Guaging*, page 91; see also page 93, *infra*.

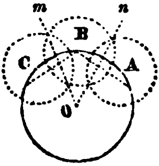
### PROBLEMS RELATING TO CIRCLES.

1. *To find the diameter of a circle from the circumference, and to find the circumference from the diameter.*—As 7 is to 22, or as 113 is to 355, so is the diameter to the circumference, nearly. And as 22 is to 7, or as 355 is to 113, so is the circumference to the diameter, nearly. *Or thus:* Multiply the diameter by 3·1416 for the circumference; or divide the circumference by 3·1416, or multiply it by ·31831 (the reciprocal of 3·1416) for the diameter.



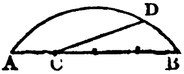
A *sine*, or *right sine*, of an arc, is the line drawn perpendicularly from the arc to the diameter; as A G. The *versed sine* is the part of the diameter intercepted between the arc and its sine; as E G. A *tangent* is a line touching a circle without cutting it.

---



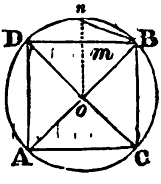
2. *To find the centre of a given circle.*—Take any three points A B C in the circumference of the circle, and join A B and B C; bisect A B and B C with the perpendiculars *n o* and *m o*, meeting each other in the point *o*; then *o* is the centre required.

By this problem it will be easy to describe a circle through any three given points that are not in the same straight line, or to describe a circle about a given triangle. Also, if any arc of a circle be given, the whole circle may be readily described.—*Keith's Measurer.*



3. *To find the length of the arc of a circle.* By Construction.—Divide the chord A B into four equal parts; set one part, A C, on the arc from B to D; draw C D, and it will be nearly equal to half the length of the arc.

By Calculation.—Multiply the radius of the circle by the number of degrees in the given arc, and that product by ·01745329 (the length of one degree of a circle when the radius is 1); the last product will be the length of the arc; for the circumference of a circle whose radius is 1, is nearly 6·28318, (see page 90, *infra*,) hence 6·28318 divided by 360 degrees, gives ·01745329, the length of the arc of 1 degree to radius 1; and the length of the arc of 1 degree to any other radius must be multiplied by that radius; and this product being multiplied by the number of degrees in the arc, will obviously give the length of the specified arc. This rule is correct, but the following approximative one is frequently used:—From eight times the chord of half the arc, subtract the chord of the whole arc, and one-third of the remainder will be the length of the arc, nearly.



4. *In a given circle to inscribe a square.*—Draw any two diameters, A B and C D, perpendicular to each other; then connect their extremities, and that will give the inscribed square A D B C.

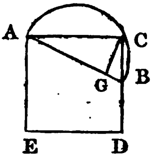
If a side of the square, as D B, be bisected in *m*, and a line *o m n* be drawn from the centre of the circle to cut the circumference, then if the line B *n* be drawn, it will be the side of an octagon inscribed in the circle.—*Keith's Measurer.*

*Concentric circles* are those which have the same centre, and the space included between their circumference is called a *ring*. The space included by two parallel chords is called a *circular zone;* as A B F E. And the space included between the intersecting arcs of two eccentric circles is called a *lune*.

There is no figure that affords a greater variety of useful properties than the circle; it is the most capacious of all plane figures, or contains the greatest area within the

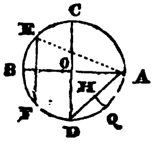
---

5. *To find the side of the inscribed square.*—Extract the square root of twice the square of the radius, or semi-diameter, of the circle, and the root is the side of the greatest square that can be inscribed in it. *Or thus:* Multiply the diameter of the circumscribing circle by ·7071068, or the circumference by ·2250791; the product will, in either case, give the side of the inscribed square.



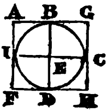
6. *To make a square equal in area to a given circle.*—Divide the diameter A B into fourteen equal parts, and make A G equal to eleven of these parts; erect the perpendicular G C, and join A C; then the square A E D C, formed upon A C, is equal to the whole circle whose diameter is A B, exceedingly near the truth.

7. *To find the side of a square equal in area to a given circle.* By Calculation.—Multiply the diameter of the circle by ·8862269, or the circumference by ·2820948.



By Construction.—Draw the two diameters A B and C D at right angles to each other; bisect the radius O C by a line from one end of the diameter A B, meeting the circumference in E; the line A E will then be the side of a square nearly equal in area to the given circle. And if the line E F be drawn parallel to C D, it will be one-fourth of the circumference, nearly; or, three times the diameter A B or C D, and once the versed-sine Q H of the angle A O D, will be the circumference, nearly.

8. *To find the diameter and circumference of a circle equal to a given square.*—Multiply the side of the square by 1·1283791 for the diameter, and by 3·5449076 for the circumference of the circle.



9. *To circumscribe a square about a circle.*—Draw any two diameters I C and B D, at right angles to each other; through the points B, C, D, I, and perpendicular to B D, I C, draw the outer lines, which will be the square.

10. *To find the diameter and circumference of a circle circumscribing a square.*—Multiply the side of the inscribed square by 1·4142136 for the diameter, and by 4·4428829 for the circumference of the circumscribing circle.

same perimeter; or has the least perimeter about the same area.

To FIND THE AREA OF A CIRCLE.—I. Multiply the radius, or half the diameter, by half the circumference; or, which is the same thing, multiply the circumference* by the diameter, and take one-fourth of the product; in either case it will give the area.†

II. Multiply the square of the radius by 3·1416; or

---

* The reason for this rule is easily inferred from the doctrine of the regular polygon; for in any circle a polygon may be inscribed of as many sides as we please; and by increasing the number of sides, the polygon will approach nearer and nearer in dimensions to the circle, so as to come within any assigned difference. But the area of a regular polygon is equal to half the perimeter multiplied by the perpendicular; and, consequently, the area of a circle is equal to half the circumference multiplied by the radius, or half the diameter.—*Bonnycastle's Mensuration.*

† EXAMPLE OF A CIRCLE BY RULE I.

(1.) What is the area of a circle whose diameter is 42 and circumference 131·946?

$$\begin{array}{rl} 2\,)\,131{\cdot}946 & \\ \hline 65{\cdot}973 & \text{Half circumference.} \\ 21 & \text{Half diameter.} \\ \hline 1385{\cdot}433 & \text{Ans.} \end{array}$$

By applying the calculation of this rule to a circle the diameter of which is unity, or 1, factors are obtained which are of the greatest use in calculations respecting circles and circular figures. Whatever the dimensions of a circle may be, it is evident that the circumference must always bear the same ratio to the diameter; for a circle of any diameter (as half an inch, an inch, or two inches) is the exact representative of every other circle of any magnitude whatever, from the head of a cask to the disk of the sun. If, therefore, we can ascertain the ratio between any circle and its diameter, we have only to apply this ratio as a rule of proportion to any other circle of which we can measure the diameter, which is easily done, though, in many cases, to measure the circumference itself would be impracticable. Mathematicians, in different ages, have endeavoured to find the exact ratio the circumference and diameter bear to each other, which has been called, "rectifying the circle;" but this may be proved to be, strictly speaking, impossible; the quantities being such as are called incommensurable. But though the relation between the diameter and circumference cannot be exactly expressed in numbers, it may yet be approximated to any degree of exactness. Archimedes, about two thousand years ago, defined the proportion to be nearly as 7 to 22. Other and the square of the diameter by ·7854, and the product will, in either case, be the area.*

III. Multiply the square of the circumference by ·07958, or divide it by 12·5664, and the product or quotient, as the case may be, will be the area.

---

nearer ratios have since been successively assigned, namely, as 106 to 333, as 1702 to 5347, and as 113 to 355, &c. This last ratio is very useful for being turned into a decimal, and it agrees with the truth to the sixth figure inclusively; but the nearest approximation yet demonstrated is as 1 to 3·14159, &c., the decimal being extended to 128 places. This, however, is much further than can be useful for any practical purpose; and, in most cases, it will be sufficient to take the ratio as 1 to 3·1416, which is not quite a hundred-thousandth beyond the truth; or even as 1 to 3·14, which is near enough where no great nicety is requisite. Taking, therefore, the diameter of a circle as 1, and its circumference (for the reasons above stated) at 3·1416, the area will (by Rule I.) be as follows:—

Half 3·1416, the circumference = 1·5708
Half 1, the diameter.......... = ·5

Factor referred to in the rule ·7854

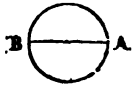
The factors thus obtained are the foundation of Rule II., which being the rule in most common use in excise calculations, ought to be well fixed in the memory.

* EXAMPLES OF CIRCLES BY RULE II.

(2.) Let the diameter of a circle, A B, be 5, what is its area?

$5 \times 5 = 25$ Square of the diameter.
·7854 Factor

19·6350



(3.) What is the area of a circle the diameter of which is 42?

$42^2 \times \cdot7854 = 1764 \times \cdot7854 = 1385\cdot4456$. Ans.

Hence, if the area of a circle be divided by ·7854, the square root of the quotient will be the diameter; and if the root of the area of a circle be extracted, it will give the side of a square equal in area to the circle. The area of a circle multiplied by ·6366197, and the square root of the product extracted, will give the side of the inscribed square.

If it be required to find the area in gallons or bushels instead of inches, the area, found as above, may be divided by the number of inches contained in a gallon or bushel, as the case may be. (See page 84.) Or, which is the more usual and readiest mode, the square of the diameter may be multiplied or divided at once by such a number as will produce the same result as if the square of the diameter were multiplied by ·7854, and afterwards divided by the number of inches contained in a gallon or bushel respectively. The number thus fouud is called a circular divisor, or factor, as the case may be, and is found as follows:—

**IV. TO FIND THE AREA OF THE SECTOR OF A CIRCLE.**—Find the area of the whole circle; and if the sector be a semicircle, a quadrant, an octant, or any known even part of a circle, take one-half, one-quarter, &c., of the whole area for the answer.

**V.** Multiply the radius by half the length of the arc of the sector; the product will be the area.

---

### TO FIND A CIRCULAR DIVISOR FOR GALLONS OR BUSHELS.

Divide the number of cubic inches contained in a gallon or bushel by ·7854, the circular factor for unity; this will give the number of cubic inches contained in a circular gallon or bushel, as the case may be. Thus:

277·274 ÷ ·7854 = 353·0362. Circular divisor for gallons.
2218·192 ÷ ·7854 = 2824·2879. Circular divisor for bushels.

### TO FIND A CIRCULAR FACTOR FOR GALLONS OR BUSHELS.

Divide ·7854, the circular factor for unity, by the number of cubic inches contained in a gallon or bushel respectively; the quotient is the circular factor for one gallon or one bushel, as the case may be. Thus:

·7854 ÷ 277·274 = ·00283257. Circular factor for gallons.
·7854 ÷ 2218·192 = 00035407. Circular factor for bushels.

The circular divisors and factors inserted in the Table page 57, are found in the manner above explained. The following example will show that the result is the same, whichever way the work be performed:—

(4.) What is the area, in gallons, of a circle the diameter of which is 34 inches, and the depth 1 inch?

| By the rule. | By the circular divisor. | By the circular factor. |
|---|---|---|
| 34 | 34 | 34 |
| 34 | 34 | 34 |
| 1156 | 353·036 ) 1156 ( 3·274 | 1156 |
| ·7854 | | ·00283257 |
| 277·274 ) 907·9224 ) 3·274 | | 3.27445092 |

For facility of reference, tables are constructed founded on the foregoing calculations. (See the Table of Areas of Circles in Imperial Gallons, *infra.*)

Rule III. is founded on the following calculation:—It has been seen that the circumference multiplied by the diameter and divided by 4, will give the area; and as the diameter is equal to the circumference divided by 3·1416, the circumference multiplied by itself, (that is, the square of the circumference) divided by 3·1416, and the quotient by 4; or divided at once by the factor, 12·5664 = 4 × 3·1416, will give the area. The same result would be obtained by the following proportion:—As 88 is to 7, or as 1420 is to 113, so is the square of the circumference to the area. Hence, if the area of a circle be divided by ·07958, the square root will be the circumference.

VI. As 360 is to the degrees in the arc of the sector, so is the area of the whole circle whose radius is equal to that of the sector, to the area of the sector required.*

VII. To FIND THE AREA OF THE SEGMENT OF A CIRCLE.—Find the area of a sector having the same arc as the segment; find the area of the triangle formed by the chord of the segment and the radii of the sector; then if the segment be less than a semicircle, the difference of these two areas will give the answer; but if the segment be greater than a semicircle, take their sum for the area required.

VIII. Multiply the versed sine by ·626; to the square of the product add the square of half the chord; multiply twice the square root of the sum by two-thirds of the versed sine, and the product will be the area.

IX. Divide the height, or versed sine, by the dia-

---

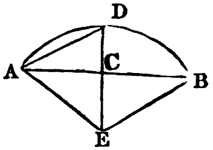
* These rules are evidently the same in effect as those for finding the area of the whole circle. The length of the arc may be found by problem 3, page 87, or by actual admeasurement.

EXAMPLES OF SECTORS, BY RULE V.

(5.) Let A D B E be a sector, whereof the radius A E measures 17 inches, and the arc A D B 26 inches; the area is required.

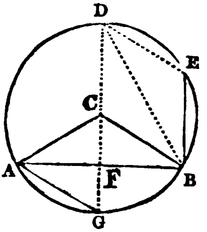
Inches.
17 Radius.
13 Half the arc.

Ans. 221 inches.



(6.) Let A D E B C A be a sector greater than a semicircle whose radius A C is 20·6; the chord B D of the arc D E B, 35·4; and the chord B E, of half that arc, 20·35962; required the area.

The length of the arc B E D will be found, by prob. 3, page 87, to be 42·49232; then 42·49232 × 20·6 = 875·341792, the area of the sector required.—*Keith's Measurer.*

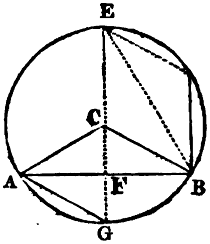


meter, and find the quotient in the table of versed-sines; multiply the number on the right hand of the versed-sine by the square of the diameter, and the product will be the area.*

**X. TO FIND THE AREA OF A CIRCULAR ZONE.**—Find the area of that part of the zone which forms a trapezoid,

---

EXAMPLE OF A SEGMENT, BY RULE VII.



(7.) The radius A C is 10, and the chord A B is 18; what is the area of the segment A G B?

Here $AF = \frac{1}{2}AB = 9$; and since $AC^2 = AF^2 + FC^2$, (see page 73,) therefore $FC^2 = AC^2 - AF^2 = 10^2 - 9^2 = 100 - 81 = 19$, and extracting the root, gives $FC = \sqrt{19} = 4{\cdot}3588989$; whence $FG = CG - CF = 10 - 4{\cdot}3588989 = 5{\cdot}6411011$, and $AG^2 = AF^2 + FG^2$ (see page 73) $= 9^2 + 5{\cdot}6411011^2 = 112{\cdot}822022$, and extracting the root, gives $AG = 10{\cdot}622$, nearly; then $\frac{10{\cdot}622 \times 8 - 18}{3} = \frac{84{\cdot}976 - 18}{3} = \frac{66{\cdot}976}{3} = 22{\cdot}325 =$ arc A G B; and $\frac{22{\cdot}325 \times 10}{2} = 22{\cdot}325 \times 5 = 111{\cdot}625 =$ area of sector C A G B. Also, $\frac{18 + 10 + 10}{2} = \frac{38}{2} = 19 =$ half the sum of the sides A C, C B, and B A; whence $19 - 10 = 9 =$ first and second difference, and $19 - 18 = 1 =$ third difference. And $\sqrt{19 \times 9 \times 9 \times 1} = 9\sqrt{19} = 9 \times 4{\cdot}3588989 = 39{\cdot}2300901 =$ area of the triangle B C A; whence $111{\cdot}625 - 39{\cdot}23 = 72{\cdot}595 =$ area of the segment required; it being, in this case, less than a semicircle.

The following is a near approximation to the above rule:—To the cube of the versed-sine, divided by twice the length of the chord, add two-thirds of the product of the chord multiplied by the versed-sine, and the sum will be the area of the segment, nearly.

The table to which Rule IX. refers, and which table will be found in a subsequent page, is formed of the areas of the segments of a circle whose diameter is 1, and which is supposed to be divided, by perpendicular chords, into 1000 equal parts. The reason of the rule itself depends upon the property referred to in Theorem 16, page 86.

* EXAMPLE OF A SEGMENT, BY RULE IX.

(8.) If the diameter of a circle be 80 inches, required the area of a segment thereof whose versed sine is 30 inches.

30·000 ÷ 80 = ·375 Tabular versed sine.
·269013 Tabular segment to versed sine ·375.
6400 Square of the diameter, 80.
1721·6832 Ans.

by the rule in page 80, and the area of one of the segments at the end of the trapezoid, by the rule in page 92; add the area of the trapezoid to twice the area of the segment, and it will give the area of the zone required.

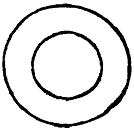
XI. TO FIND THE AREA OF A CIRCULAR RING.—Subtract the area of the smaller circle from that of the greater; multiply the difference by ·7854; the product will be the area required.*

XII. Multiply the sum of the diameters by their difference, and that product by ·7854, and it will give the area required.

XIII. TO FIND THE AREA OF A LUNE.—Find the areas of the two segments from which the lune is formed, and the difference will be the area required.†

---

* EXAMPLES OF A CIRCULAR RING.



(9.) What is the area of the space included between two circles, the diameter of the greater circle being 50 inches, and of the less, 25?

Here $50^2 = 2500$, and $25^2 = 625$; then $(2500 - 625) \times ·7854 = 1875 \times ·7854 = 1472·625$ inches. Ans.

The area of a circular ring may also be found as follows:—

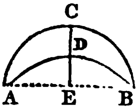
Let $c$ = circumference of greater circle, $b$ = breadth of ring, and $n = 3·14159$; then area of annulus, or ring, $= b\,(c - n\,b)$.

(10.) What is the area of the space included between two concentric circles, the circumference of the greater circle being 157·08 inches, and the breadth of the ring, 12·5?

Here $12·5\,(157·08 - 3·14159 \times 12·5) = 12·5\,(157·08 - 39·269875) = 12·5 \times 117·810125 = 1472·6265$ = area of ring.

† EXAMPLE OF A LUNE.

(11.) Required the area of the lune A B C D, the chord A B being 48 inches, and the part of the diameter cut off by it, C E, 18 inches, and D E, 12 inches?



Here $C\,E + \frac{A\,E^2}{C\,E} = 18 + \frac{24^2}{18} = 18 + \frac{576}{18} = 18 + 32 = 50$ = diameter of circle of which A C B is a segment; then $\frac{18}{50} = ·36$ = tabular versed-sine.

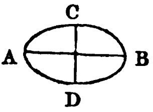
·25455055 Tabular area to versed-sine ·36.
2500 Diameter squared.

636·376375 Area of segment A C B.

By the same rule, the area of segment A D B will be found to be 402·56568; whence, $636·376375 - 402·56568 = 233·810695$ = area of lune A C B D A.

### 5. *Of the Ellipsis, Parabola, and Hyperbola.*[*]

AN Ellipsis is a curved figure bounded by a circumference, as A C B D, and described from two points in its longest diameter; it is a curve such as the planets are supposed to describe in revolving about the sun. If two lines are drawn perpendicular to each other, and terminated both ways by the circumference, as A B, C D, they are called the *transverse* and *conjugate* diameters, or *axis;* the longest line, A B, being the transverse axis, and the shorter, C D, the conjugate. The two points from which the circumference is described are called the *focii.*



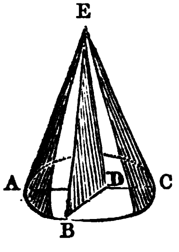
---

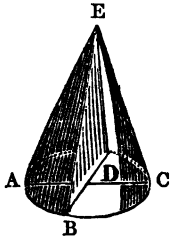
[*] CONIC SECTIONS.

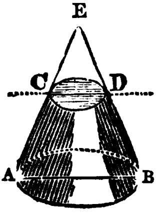
"These three lines, figures, and planes, (the ellipsis, parabola, and hyperbola,) are called *conic sections*, and form one of the most important parts of mathematics, which is distinguished for elegance; demonstrating, with surprising simplicity and beauty, and in the most harmonious connexion, the different laws according to which the Creator has made worlds to revolve, and the light to be received and reflected, as well as the ball thrown into the air by the playful boy to describe its line until it falls again to the earth."—*Converzations Lexicon.*

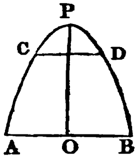
A *cone*, (as will be seen in the Mensuration of Solids) is a solid having a circle for its base, and its top terminated in a point, or *vertex*, and formed, according to Euclid, by the revolution of a right-angled triangle (as B D E, fig. 1) about one of its sides (as D E) which remains fixed, the point B describing the circular base.

If a cone be cut by a plane passing through the vertex, the section is a triangle; as B D E, fig. 2. If a cone be cut parallel with its base, the section is a circle; as C D, fig. 3.





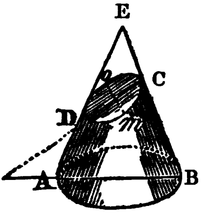


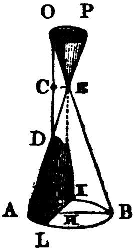


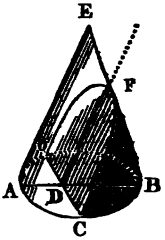
A **PARABOLA** is a curve, supposed to be the line which would be described by a cannon ball; as A P B; and an *hyperbola* is a curve more open than the parabola. The branches or sides of these two figures are geometrically described as indefinite, but, for the purposes of mensuration, they are

---

If the cone be cut obliquely, that is, nearer to the base at one end than at the other, a curve is obtained, which is called an *ellipsis*; as D C, fig. 4. If the section be made parallel with one side of the cone, the curve is called a *parabola*, as C F O, fig. 6. If the section forms a greater angle with the base than is made by the side of the cone, the curve obtained is called an *hyperbola*, as I L D, fig. 5.



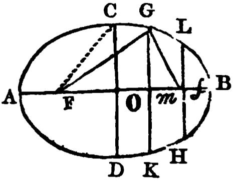




THEOREMS RELATING TO THE ELLIPSIS.

1. The sum of two straight lines drawn from the foci of an ellipsis to any point in the circumference is equal to the transverse axis, and is always the same, to whatever point the lines are drawn. On this is founded the usual method of describing an ellipsis. (See prob. 1.)

2. As the square of the transverse diameter of an ellipsis is to the square of the conjugate, so is the rectangle of the abscissa to the square of the ordinate.



3. As the square of the transverse diameter is to the square of the conjugate, so is the square of the ordinate to the rectangle of the abscissa.

4. The square of the distance of the focus from the centre is equal to the difference of the squares of the semi-axis; thus, F O$^2$ = A O$^2$ = C O$^2$

usually terminated by a straight line, or ordinate, joining them at the widest part; as A B. A line drawn from the *vertex*, or uppermost point, so as to divide the parabola or hyperbola into two equal parts, is called the *axis;* as O P. And the point to which every part of the curve has a fixed relation is called the *focus.*

An *ordinate in an ellipsis* is a right-line drawn from

---

5. The area of an ellipsis is a geometrical mean proportional between the area of two circles whose diameters are the transverse and conjugate diameters of the ellipsis.

### THEOREMS RELATING TO THE PARABOLA.

6. The square of any two ordinates of a parabola are to each other as their corresponding abscissas.

7. The distance of the focus from the vertex is equal to the square of any ordinate divided by four times its abscissa.

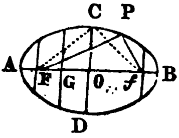
8. The area of a parabola is equal to two-thirds of the area of the circumscribing parallelogram.

### THEOREMS RELATING TO THE HYPERBOLA.

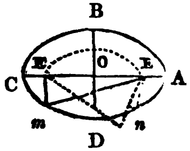
9. As the square of any ordinate to the transverse diameter of an hyperbola is to the rectangle contained under the corresponding abscissa and the sum of that abscissa and the transverse diameter, so is the square of the conjugate diameter to the square of the transverse.

10. The square-root of the sum of the squares of the semi-axes is equal to the distance of the focus from the middle of the transverse axis.

### PROBLEMS.



1. *To construct an ellipsis from given focii.*—At a given distance on the plane on which the ellipsis is to be described, fix two pins, F and *f*, and pass a string P *f* F P round them. Keep the string stretched by a pencil P and move the pencil along, keeping the string at the same tension; then the ellipsis A B C D will be described.

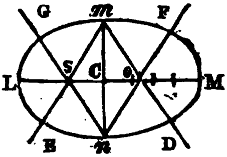


2. *To determine whether a given oval figure be a true ellipsis.*—Find the two focii E, E, with the radius A O, and D as a centre; attach a string, and move the point round, as in prob. 1; if the string extends beyond the curve, as at *n*, the figure is less than an ellipsis; if it falls short of the curve, it is greater.

5. *To find the circumference of an ellipsis.*—Multiply the square-root of half the sum of the squares of the two diameters by 3·1416, and the product will be the circumference, nearly; or multiply the sum of the two diameters by 1·5708, the product will be the circumference, nearly.

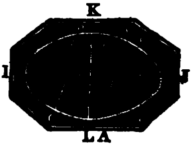
any point in the curve perpendicular to either of the diameters; and an *ordinate in a parabola* or an hyperbola, is a right-line drawn from any point in the curve perpendicular to the axis The *abscissa* is that part of the axis which is contained between the vertex and the ordinate.

---

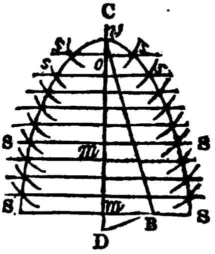


3. *To describe an ellipsis, the two diameters being given.*—Draw the two diameters L M, *m n*; make L *o* equal to *m n*, the shorter diameter; divide the remaining part, *o* M, into three equal parts, and set off two of them from C to S; through S draw *m* S E and *n* S G; and at a like distance from C, draw *m* D and *n* F; with the radius L S and centre S describe the arcs E L G and F M D; with *n* as a centre and radius *n* G, describe the arc G F; and with *m* as a centre and radius *m* E, describe the arc E D, which will complete the ellipsis required.

4. *To find the centre of any given ellipsis, or oval figure, and draw the transverse and conjugate diameters.*—Strike a line (with a chalk line, if the figure be large) on any part of the figure, as A B; at a convenient distance draw another line parallel to it, as C D (see prob. 1 and 2, p. 66); draw a line, as F, through the middle of the lines A B and C D, and the middle of this latter line at *o* will be the centre of the figure. From the centre *o*, with a line (or string) of a suitable length, make two marks in the periphery of the figure, as at G and H, at equal distances from *o*; from these marks draw the line G H, which bisect (*i. e.* divide into two equal parts) in the point *d*, from which point, and through the centre *o*, strike the transverse diameter, I J, upon which at *o* draw the perpendicular L K, for the conjugate diameter. The figure being thus quartered, the distances I K, K J, J L, L I, will be equal, if the operations have been correctly performed.



5. *To construct a parabola, the abscissa and any ordinate to the axis being given.*—Bisect the given ordinate S *m* in B, join B *v*, and draw B D perpendicularly to it, meeting the axis produced in D; make *o v* and *v* C each equal to D M, and *o* will be the focus of the parabola; take any number of points, *m*, *m*, &c., in the axis, through which draw the double ordinates *s m s*, &c., of an indefinite length; with the radii *o* C, *m* C, &c., and centre O, describe arcs cutting the corresponding ordinates in the points S, S, &c., and the curve S *v* S, drawn through all the points, will be the parabola required.



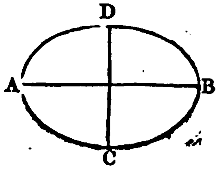
**To find the area of an ellipsis.**—Multiply one of the semi-axes by the other, and by 3·1416; or one of the axis by the other, and by ·7854. Or multiply ·7854 by one axis and the product by the other; the last product, in either case, will be the area.*

---

* EXAMPLES OF ELLIPSIS.

(1.) What is the area of an ellipsis whose transverse diameter, A B, is 24, and the conjugate, C D, 18.

| (i.) | (ii.) | (iii.) |
|---|---|---|
| 12 | 24 | ·7854 |
| 9 | 18 | 24 Trans. |
| 108 | 433 | 18·8496 |
| 3·1416 | ·7854 | 18 Conj. |
| 339·2928 Area. | 339·2928 Area. | 339·2928 Area. |



(2.) Required the area of an ellipsis, of which the semi-axes are 436 and 254 inches. Ans. 347913·3504 square inches.

If it be required to find the area in bushels or gallons, the product of the two diameters may be divided by the proper circular divisors (see page 96,) namely, by 353·636 for gallons, 2824·29 for bushels. Or it may be multiplied by the proper circular multipliers (·0028325 for gallons, ·0003541 for bushels, see page 90); and the quotient or product, as the case may be, will be the area in gallons or bushels.

Another method of ascertaining the area of an ellipsis in imperial gallons, is by means of the Table of Circular Areas, *infra*, the rule for which, as published in Mr. Todd's tables, printed at the Government press, is as follows:—"From the sum of the areas of the transverse and conjugate diameters subtract the area of their difference, and half the remainder will be the area in imperial gallons."

(3.) The transverse diameter A B is 105·3 inches, the conjugate diameter C D 55·8 inches, and the difference of these diameters, that is, A B — C D = 49·5 inches; what is the area of the ellipsis A C B D, in imperial gallons?

| | Areas of circles in imperial gallons. |
|---|---|
| Transverse diameter A B 1053 | 31·4077 |
| Conjugate diameter C D 55·8 | 8·8196 |
| Sum of the areas of transverse and conjugate | 40·2273 |
| Difference of the above 49·5 | 6·9405 |
| Double the area in imperial gallons | 33.2868 |

Hence 33·2868 divided by 2 gives 16·6434 imperial gallons, the correct area of the ellipse A C B D.

TO FIND THE AREA OF A PARABOLA.—Multiply the base by the height, and two-thirds of the product will be the area.*

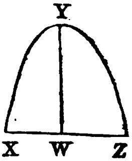
TO FIND THE AREA OF AN HYPERBOLA.—Multiply the transverse by the abscissa; to the product add five-sevenths of the square of the abscissa, and multiply the square-root of the sum by 21; add four times the square-root of the product of the transverse and abscissa to the product last found, and divide the sum by 75; divide four times the product of the conjugate and abscissa by the transverse, and this last quotient multiplied by the former will give the area required, nearly.†

---

This will be found the readiest mode of obtaining the area of an ellipsis, and the accuracy of the rule is unquestionable, it being founded upon the property of an ellipsis as defined in Theorem 5, page 97.

The area of an elliptic segment may be found by the Table of Circular Segments, as follows:—Divide the height of the segment by that axis of the ellipse of which it is a part, and find, in the table, a circular segment whose versed-sine is equal to the quotient; multiply the segment thus found and the two axes of the ellipsis continually together, and the product will give the area required.

The area of an elliptical ring, or the space included between the circumference of two concentric and similar ellipses, may be found by subtracting the area of the less ellipsis from the area of the grearter.

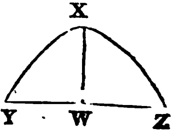


* EXAMPLE OF A PARABOLA.

(4.) What is the area of the parabola X Y Z, whose height W Y is 12, and the base, or double ordinate, 16.

$12 \times 16 = 192$, and $\frac{2}{3} \times 192 = \frac{384}{3} = 128$. Ans.

The area of the *frustum* of a parabola (being that which remains after a part has been cut from the top by a line parallel to the base, as A C D B, fig. 1, page 96) may be ascertained as follows:—Find a third proportional to the sum of the bases and one of them, to which add the other base; the sum, multiplied by two-thirds of the height, will give the area.



† EXAMPLE OF AN HYPERBOLA.

(5.) In the hyperbola X Y Z, the transverse axis is 30; the conjugate, 18; and the abscissa, or height, (X W,) is 10; what is the area? Ans. 151·6776.

## 6. *Of Irregular and Doubtful Curves.*[*]

Most of the superficies that require measuring will come within one or other of the foregoing definitions; but, as it is sometimes difficult to ascertain to which definition a figure properly belongs, it is convenient to have a rule by which any superficies can be measured without strictly defining its geometrical proportions. Such a rule has been accordingly adopted; and as, when accurately performed, it produces a very near approximation to the true measure,

---

[*] The rule and examples given in this section for finding the area of curved figures by means of equidistant ordinates, are from Mr. Moss's "Treatise of Gauging," (third edition, 1799). His observations thereon are as follows:—

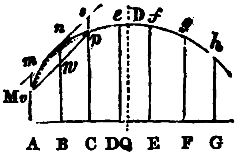
MEASURING PLANES BY EQUIDISTANT ORDINATES.

"The general method of approximating the areas of curvilineal planes, by means of any given number of equidistant perpendicular ordinates, or diameters, was first demonstrated by the most illustrious Newton, and is well known to be a subject of very great importance in speculative mathematics. And although this general method has already been adapted to the present subject, (particularly, first of all, by that excellent mathematician, the late Mr. Robert Shirtcliffe, in his 'Theory and Practice of Gauging,' and afterwards by my late worthy and ingenious friend, Mr. Samuel Farrer, in the 'Appendix to Overley's Gauging,') yet we find it has not sufficiently merited the attention of every practical gauger, which, it is presumed, is owing to the tediousness of the rules hitherto laid down. For this reason, I have endeavoured to put the matter in as clear and as practical a light as the nature of the subject can possibly admit of, and have illustrated the same with suitable examples; and, moreover, to oblige the speculative readers, I have given in the subjoined note the demonstration of this method; which, indeed, does not essentially differ, except in one circumstance, from what is given by that incomparable and most profound mathematician, the late Mr. Thomas Simpson, in his Dissertation, page 109. And from the said demonstration, I have deduced two general rules; one for approximating, with any even number of equidistant perpendicular ordinates, the area of any curvilineal space, bounded by two perpendicular right-lines and a curve; and the other for obtaining, with any odd number of equidistant perpendicular ordinates, (or diameters,) the true area, very nearly, of any curvilineal space comprehended either by a right line and a curve, or wholly by a curve. But it is to be observed, that these rules, for the most part, will not approximate the areas of such planes as occur in the subject of gauging so near as the following general rule, [*the rule given in the text,*] which determines, very nearly, the true measure of any curvilineal plane bounded by three perpendicular right-lines and a curve of any kind; or by two parallel lines and two curves of any kind.

---

"It may be proper to observe here, that it will be always necessary, according to our method of considering the matter, to take an odd number of ordinates; which, indeed, is unavoidable when an ordinate is taken (as it always is in the practical method of taking the dimensions of a curvilineal back, &c.) exactly in the middle of the two extreme ordinates; and therefore this method, which is comprehended in one general rule, let the odd number of ordinates be what it will, claims the preference in point of expedition, since it will appear, by the following examples, that a large number of ordinates does but very little increase the labour and computation, which is far from being the case in any rules (founded on indubitable principles) I have hitherto met with."—*Moss's Gauging*, page 235.

PROPOSITION.



"Suppose the black curve line *v n p* to represent a small portion of any curve whatever, and the dotted line *v n p* a small portion of a common parabolic curve, each passing through the extremities of the three equidistant perpendiculars A *v*, B *n*, C *p*; to find an expression in terms of those three ordinates (or diameters), and their common distance A B (B C, &c.) that shall accurately measure the parabolic space, and, consequently, that comprehended by the black curve-line, the right-line A C, and the perpendiculars A *v*, C *p*, indefinitely near.

DEMONSTRATION.

"Suppose the axis (P Q) of the parabolic curve, to be parallel to the ordinates of the proposed curve, draw the right-line (or ordinate) *v w p*, and parallel thereto draw M *n* S, which is well known to be a tangent to the parabolic curve, at the point *n*; produce A *v* and C *p* to meet M S in *m* and *s*. Then because it is proved, by the writers on Fluxions, that a parabola is two-thirds of a rectangle of the same base and altitude, it follows, from the very same principles, that the parabolic area *v n p w v*, is two-thirds of the parallelogram *v m s p*. Now, it is evident, from common Geometry, that B *n* $(= \frac{A m + C s}{2}) \times 2 A B$, is equal to the area of the quadrilateral space A *m s* C, and also that the area of the quadrilateral A *v m p* C is expressed by $\overline{A v + C p}$ (2 B *w*) × A B; moreover, it is plain that the quadrilateral A *m s* C is greater than the parabolic arc A *v n p* C, by exactly half what the quadrilateral A *v w p* C wants of that area; consequently, twice A *m s* C (= twice the parabolic space A *v n p* C + *v n p w*. or twice *v m n s p*) added to A *v w p* C, gives three times the parabolic area A *v n p* C; which area alone will therefore be expressed by $\frac{2 B n \times 2 A B \times \overline{A v + C p} \times A B,}{3}$ or $\overline{A v + 4 B n + C p} \times \frac{A B}{3}$; and it has received the sanction of the Board of Excise, and has been published by their authority.

---

therefore, when the three ordinates (or perpendiculars) are taken pretty near to each other, the common parabolic curve passing through their extremities will very nearly coincide with any other curve passing through the same three points; because, as a parabolic curve has an infinite variation of curvature, it may be justly conceived to be, very nearly, coincident with any other curve for a small distance; whence, it is plain, the above expression, $(\overline{A\,v + 4\,B\,n + C\,p} \times \frac{A\,B}{3})$ will exhibit the accurate measure of the parabolic space A $v$ $n$ $p$ C; and, consequently, very nearly (or accurately, under *one* particular circumstance) of that bounded by the right line A C, the perpendiculars A $v$, C $p$; and any other curve line passing through the extremities ($v$, $n$, and $p$) of the three equidistant perpendiculars A $v$, B $n$, and C $p$, Q. E. D.

"COROLLARY 1.—From hence it is easy to deduce a *general rule* for determining, very nearly, with any odd number of equidistant ordinates, or perpendiculars, whatever, the measure of any curvilineal plane, bounded at its ends by right lines parallel to each other. For, let the perpendicular distance of those two given parallel lines A $v$ and G $h$, be divided into equal parts by any odd number of perpendiculars, B $n$, C $p$, D $e$, &c., which, in some curves, are considered as ordinates, and in others, (particularly the parabola,) as diameters; and the greater the number taken, the greater will be the degree of accuracy, in every curvilineal plane except the parabola, wherein it is strictly true. Then by the very same reasoning as we found $\overline{A\,v + 4\,B\,n + C\,p} \times \frac{A\,B}{3}$ for the area of A $v$ $n$ $p$ C, we get $\overline{C\,p + 4\,D\,e + E\,f} \times \frac{C\,D}{3}(\frac{A\,B}{3})$ for the area of C $p$ $e$ $f$ E, and likewise that of E $f$ $g$ $h$ G $= \overline{E\,f + 4\,F\,g + G\,h} \times \frac{A\,B}{3}$ &c.; therefore the sum of those areas (each having one common multiplier) will be expressed by $\frac{A\,B}{3} \times \overline{A\,v + 4\,B\,n + 2\,C\,p + 4\,D\,e + 2\,E\,f + 4\,F\,g + G\,h}$ = the area of the curvilineal plane A $v$ $n$ $p$ $e$ $f$ $g$ $h$ G, nearly; whence the general rule is manifest. (See page 107.)

"COR. 2.—If, at the extremity of any curvilineal space whose area is sought, the ordinate is supposed to vanish, then (A $v$ being nothing) we have $\overline{4\,B\,n + 2\,C\,p + 4\,D\,e + 2\,E\,f + 4\,F\,g + G\,h + \&c.} \times \frac{A\,B}{3}$ a general expression for approximating, with any even number of equidistant perpendiculars, the area of any curvilineal plane, bounded by two perpendicular right-lines and a curve. The above expression, in words, will be as follows:—To four times the sum of the first, third, fifth, &c., perpendiculars (beginning at the least) add the last, and also double the sum of all the rest; this total being multiplied by one-eighth of their common distance, the product will be the required area, nearly.

This measurement is effected by means of what are called *equidistant perpendicular ordinates;* and although

---

" COR. 3.—Hence it appears, that if, at both the extremities of any curvilineal plane, the ordinates, or perpendiculars, be supposed nothing, we shall have $4\,\overline{B\,n + 2\,C\,p + 4\,D\,e + 2\,E\,f + F\,g + G\,h + \&c.} \times \frac{AB}{3}$ a general expression for determining, with any odd number of ordinates, the true measure, nearly, of any curvilineal plane, bounded by one right-line and a curve, or wholly by a curve. The expression, in words, will be thus:—To four times the sum of the first, third, fifth, &c, perpendiculars, add double the sum of all the rest; this total being multiplied by one-half of the common distance of the perpendiculars, the product gives the area sought, nearly.

" SCHOLIUM.—The two preceding rules may be applied, with the greatest facility and advantage, not only to the Mensuration of land, but also to that of several kinds of artificer's work, such as glazing, painting, paving, &c.; for if the boundary of any plane figure whatever, whose measure is sought, should consist partly of right-lines, and partly of curves whose properties are unknown, such figure may then be divided into triangles and curvilineal figures, each figure bounded either by a right-line and a curve, or by two perpendicular right-lines and a curve; and therefore, any assigned number of equidistant perpendiculars may be found by actual dimensions, the measures of those curvilineal figures may, in many cases, with 5 or 6 equidistant perpendiculars, be approximated to an amazing degree of exactness; and that, too, when all other methods would prove ineffectual. It may be proper to observe further, that neither of the foregoing rules will (without taking a greater number of equidistant perpendiculars) approximate the measure of such curvilineal planes as above mentioned, so near as that deduced from Cor. 1, provided the measure of the segment, or the part bounded by the curve and the least ordinate, &c., can be truly (or very nearly) obtained; because the error increases towards the least ordinates or perpendiculars, on account of their obliquity to the curve; the length whereof, between any two adjacent perpendiculars, keeps continually increasing, and consequently gives greater latitude for different curves to pass through the same three points, in those equidistant perpendiculars."

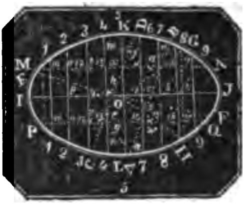
" If the number of equidistant ordinates (or perpendiculars) exceeds three; then the general rule derived from Cor. 1. will not strictly agree with those rules obtained from the general method of differences, which determines a parabolic curve of some kind to pass through any assigned number of points; whereas, in the method here laid down, common parabolic curves are supposed to be described through the first, second, and third, the third, fourth, and fifth, and throughout the fifth, sixth, and seventh, &c., ordinates; but the difference arising from computing the area of any curvilineal plane by these two methods, is extremely small, and can never be of the least consequen in the business of gauging, &c.

the rule more particularly applies to curved figures, there is scarcely any kind of superficies upon a large scale to

---

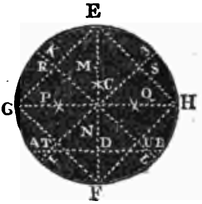
" Before we proceed to exemplify this method, it may not be amiss to give a few general directions for taking the dimensions of curvilineal backs, such as are now frequently made use of by distillers, &c."—*Moss's Gauging*, page 235, &c.

PROBLEMS.



1. *To draw the ordinates in a curved figure.*—Find the centre, and draw the conjugate and transverse diameters, I J, and K L, as in prob. 4, page 98; having thus quartered the figure, set off on each side of the centre O, on the line I J, any two equal distances, *p*, *q*, *r*, and *s*; then from the centres *p q*, and *r s*, and any convenient radius, (such as will make the distance of any two parallel lines somewhat less than what you judge the least ordinate will be taken,) describe arcs cutting each other in the points *t*, *u*, *v*, *w*, through which strike the lines M N and P Q, intersecting the conjugate diameter in the points *x* and *y*, respectively; from the point *x* set off each way, on the line M N, three, four, or more equal distances, according as it is intended to take seven, nine, or more ordinates, taking care (if the figure be the bottom of a vessel) that the distance between the extreme ordinates be somewhat less (but as little less as possible) than the transverse diameter at the top of the vessel; with the same extent set off each way, from the point *y*, the same number of equal distances on the line P Q; that is, let the distance on the two lines be equal and parallel to each other; through the points 10 10, 11 11, &c., strike the ordinates 1 1, 2 2, &c.—*Boards' Instructions*, and *Moss's Gauger.*

The general method of finding the centre of an curved figure, is to let an assistant hold one end of the tape at I, and by repeated trials to find the longest diameter at I J, which is then struck with a tape line. By the same method the conjugate diameter K L is determined, being always the longest that can be found within the figure, perpendicular to I J. (*Nesbit and Little's Gauging, p.* 57.) The distances for the ordinates are also usually set off by means of a tape and a thin piece of chalk.



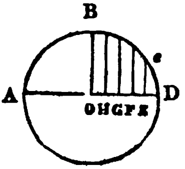
2. *To draw the ordinates upon a more limited scale.*—With a chalk-line strike a line in any part of the figure, as A B; and from centres A and B describe arcs cutting each other in *c*; through the point C, and the middle of the line A B, at the point D, erect the perpendicular E F, the middle of which, O, will be the centre. In the middle and at each side of E F, draw a perpendicular, which will form the line G H, when the figure will be truly quartered in the points

which it may not be advantageously extended. The following is the general rule* the demonstration of which is set out at length in the notes :—

---

E, H, F, G; between these points strike the lines E H, H F, F G, and G E, and through the middle of these lines, R, U, T, S, strike the lines I O J, and K O L, when the periphery will be divided into eight equal parts.—*Boards' Instructions.*

* EXAMPLES.

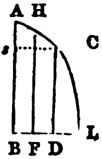


(1.) Let it be required to find the area of a circle whose diameter is 36 inches.

If, in the quadrant D O B, equidistant lines are drawn perpendicular to the diameter, their common distance E F, (F G, &c.) being 4 inches; then by the property of the circle we get their lengths, namely, E 8·24, F 13·41, G 16·12, H 17·55, O B 18.

| | |
|---|---|
| Sum of the extreme ordinates ........................ | 26·24 |
| Four times the sum of the 2nd and 4th (30·96).......... | 123·84 |
| Twice the middle ordinate (16·12)..................... | 32·24 |
| Total ........ | 182·32 × 4 ÷ 3 |
| Which, being multiplied by one third of the common distance, or (which is more convenient when the common distance will not divide) multiplied by the common distance (here 4) and the product divided by 3, gives the area of the space O B e E = ............ | 243·093 |
| Add the segment D E e, which (by reason of its smallness, with regard to the whole circle) differs but little from a semi-parabola ......................... | 10·98 |
| Gives the area of the quadrant D O B ................ | 254·073 |
| Which being multiplied by ........................ | 4 |
| Gives the area of the whole circle .................... | 1016·292 |

The area of the above circle found by the common method exceeds this calculation by $\frac{7}{1000}$ths of a gallon; and by making use of a greater number of ordinates, the difference would have been still less.



(2.) In a common parabola whose abscissa A B is 32, and the semiordinate L B 24; it is required to find the area of the part A B D C, when B D (or the semi-ordinate C s) is equal to 12.

| | |
|---|---|
| A B being 32 by the property of the curve (p. 97), F H | 30 |
| Sum of the two extremes ........................ | 56 |
| Four times the middle perpendicular .............. | 120 |
| Total ........ | 176 |
| × ⅓ of the common difference D F (F B) .......... | 2 |
| Area (strictly true) of the part A B D C ............ | 352 |

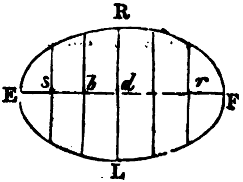
## GENERAL RULE FOR DETERMINING, VERY NEARLY, WITH ANY ODD NUMBER OF EQUIDISTANT ORDINATES, THE MEASURE OF ANY CURVILINEAL PLANE BOUNDED AT EACH END BY AN ORDINATE.

"To the sum of the first and last, or the two extreme,

---

PROOF.

| | |
|---|---|
| To the parabolic area C A *s* (see page 97) .......... | 64 |
| Add the area of the rectangle D C *s* B.............. | 288 |
| The area is (as before) ......................... | 352 |



(3.) Required the area of the curvilineal plane E R F L E, whose axis, E F, (bisected by R L,) is supposed equal to 112 inches; the perpendicular ordinates, *s* 70, *b* 79, R L 80, the next 78·6, and *r* 69; the common distance, *b d*, &c, 24; and, therefore, E *s*, (or F *r*,) 8.

| | | |
|---|---|---|
| Sum of the two extreme ordinates .... | 139 | |
| Four times the sum of the 2nd and 4th | 630·4 | |
| Double the sum of the rest (3rd) .... | 160 | |
| | 929·4 | |
| Multiplied by ⅓ of 24 ................ | 8 | |
| Area of the parts contained between the extreme ordinates ............ | 7435·2 | |
| A B 70 × E *s* 8 = 560 × 2 ÷ 3 = .... | 373·33 | Seg. E *s*. |
| I K 69 × F *r* 8 = 552 × 2 ÷ 3........ | 368 | Seg. F *r*. |
| Whole area in inches ................ | 8176·53 | |

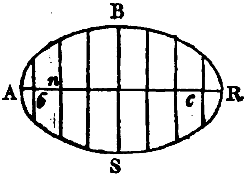
If it be required to find the area in gallons or bushels, the inches found as above may be divided by 277·274, or 2218·192 (see page 31); or such area may be found by reference to the proper tables. (See pages 53, 55, &c.)

In the foregoing examples the areas of the segments are calculated as if they were parabolas; but, on account of the smallness of E *s*, or F *r*, compared with the ordinates, it is immaterial whether such segments are considered as parabolas or the segments of circles; and because, in practice, the middle ordinate, R L, always bisects the axis, E *s* is, in fact, equal to F *r*; therefore the area of the two segments E *s* and F*r*, may be more readily obtained by multiplying the sum of the two extreme ordinates *r* and *s*, by E *s* or F *r*, and taking two-thirds of the product; or, which is the same thing, multiplying the said sum of the ordinates by twice E *s*, or twice F *r*, and taking one-third of the product; as in the following examples.

ordinates, add four times the sum of the second, fourth, sixth and eighth, or even ordinates, and also double the

---

(4.) Required the area of the curvilineal plane A B R S, A R (bisected by B S) being equal to 102 inches, the perpendicular ordinates, 54·0, 60·0, 62·2, B S 63·0, 62·4, 60·1, 54·6; their common distance 15; and, therefore, A *b* (or R *c*) 6.



| | | |
|---|---|---|
| Sum of two extreme ordinates ...................... | | 108·6 |
| Four times the sum of the 2nd, 4th, and 6th ordinates | | 732·4 |
| Twice the sum of the rest (i. e. 3d and 5th) .......... | | 249·2 |
| Total ........ | | 1090·2 |
| Multiplied by one third of 15, namely................ | | 5 |
| Area of the part D C N P = ........................ | | 5451·0 |
| Sum of the first and last ordinates ...... | 108·6 | |
| Multiplied by twice A *b* (or twice R *c*) .. | 12 | |
| One-third of the product will give the area of their segments .............. | 1303·2 ÷ 3 = | 434·4 |
| The area of the whole figure ........................ | | 5885·4 |

If the area of this figure be computed as an ellipsis, it will come out 3·63 gallons too little; "whence," Mr. Moss observes, "it is manifiest that the revenue may be greatly injured by gauging all curvilineal vessels as ellipsis; but if a due regard be paid to the method here laid down, we shall be always certain of obtaining, very nearly, the true area of any curvilineal vessel, let its form be whatever it will. Though it is here said that the revenue may be greatly injured by gauging all curvilineal vessels as ellipsis, yet I would not be understood to mean that every curvilineal vessel now made use of by brewers, distillers, &c., is greater than an ellipsis of the same tranverse and conjugate diameters; for, as a vast variety of curves may be described through the same four points, (A, B, C, D, see, for instance, the following figures,) it may sometimes happen that such a vessel may be less than an ellipsis; and therefore, the general method here given (which always approximates the true measure of the vessel, let its form be ever so irregular) will, in such case, be found serviceable to the trader as well as to the revenue, when the vessel is greater than an ellipsis.

"It will be necessary to inform the practical reader, that the semi-ordinate (*n*) of an ellipsis (see the preceding figure) is always equal to the square-root of the product of the two parts (A *n* and *n* R) of the transverse corresponding to that semi-ordinate, multiplied by the quotient of the conjugate, (B S,) divided by the transverse diameter (A R);

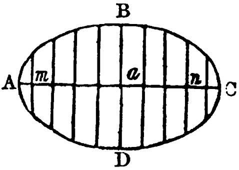
the rest; this total being multiplied by one-third of the common distance of the ordinates, the product will give

---

hence it follows, that when the semi-ordinates, thus obtained, come out greater than what appears from their actual mensuration, the vessel is then less than an ellipsis; but, on the contrary, when the semi-ordinates come out, by the above method of computation, less than what is found by mensuration, (which will, I believe, most frequently occur in practice,) then will the measure of such curvilineal vessel be greater than that of an ellipsis described through the same four points (A, B, R, S. See the preceding figure). As, for instance, in the preceding example, B S is equal to 63, A *n* 21, and *n* R 81, inches; Whence, by the above rule, 81 being multiplied by 21, gives 1701, whose square-root is 41·2; also, 63 (the conjugate) being divided by 102, (the transverse,) the quotient will be ·61; then if 14·2 be multiplied by ·61, the product will be 25·132, the first semi-ordinate; which, by mensuration, was found (see page 107) to be 30 inches. Whence it appears, by this method, that the measure of a curvilineal vessel, having its diameters equal (or in proportion) to those of the 4th example, will be considerably greater than an ellipsis described through the extremities of the same transverse and conjugate diameters."

(5.) Let the transverse and conjugate diameters of a curvilineal vessel be the same as in the last example, A R being 102 inches; and let the equidistant perpendicular ordinates be 30·4, 40·5, 48·2, (B S) 63·0, 48·4, 40·2, 30·0; their common distance (as before) 15; and, therefore, A *b* (or R *c*) 6. (See the foregoing figure.)

Area 4383·6 inches. If this vessel be considered as an ellipsis, its area will be found to be nearly three gallons more than the true area.



(6.) Find the area of the curvilineal space A B C D A, (not elliptical, but of an unknown form,) whose dimensions were obtained by actual mensuration, in the following manner: namely, the axis A C (or twice A *a*) 151·7 inches, the perpendicular ordinates 61·4, 101·2, 118·0, 123·7, B D, 125·2, 124·0, 118.6, 99·9, 57·0; their common distance 17; and, therefore, A *m* (or C *n*) 7·85.

| | | |
|---|---|---|
| Sum of the two extreme ordinates | | 118·4 |
| Four times the sum of the even ordinates | | 1795·2 |
| Twice the sum of all the rest, (namely, 3rd, 5th, and 7th) | | 723·6 |
| | | 2637·2 |
| Which, multiplied by ⅓ of 17 | | 14944·13 |
| Sum of the two extreme ordinates | 118·4 | |
| Multiplied by A *m* (or C *n*) | 7·85 | |
| | 929·440 | |
| Two-thirds whereof is the area of both segments | | 619·626 |
| Area of the whole figure A B C D A | | 15563·756 |

the required area of the space between the ordinates, very nearly;" to which the areas of the segments at the

---

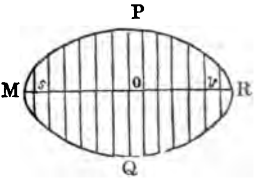
The area deduced from the Tables of Equidistant Ordinates in Shirtliffe's Gauging, page 187, differs from the above only one-hundredth part of a wine gallon.

The rule for thirteen equidistant ordinates, deduced by Mr. Moss from the Tables laid down in Shirtliffe's Gauging, page 187, is as follows:

"The sum of the 1st, 13th, and twice the (7th) middle ordinate multiplied by 41; the sum of the 2nd, 6th, 8th, and 12th ordinates multiplied by 216; the sum of the 3rd, 5th, 9th, and 11th ordinates multiplied by 27; and the sum of the 4th and 10th multiplied by 272; then the sum of these four products being multiplied by the distance of the two extreme ordinates, and that product divided by 1680, the quotient will be the area (in inches) of any curvilineal space contained between the extreme perpendiculars."

EXAMPLE.

(7.) Find the area of the curvilineal plane M P R Q, when M R (or twice M O) is 148 inches, the perpendicular ordinates are 82·4, 96·5, 112·0, 119·2, 122·6, 121·3, 122·4, (P Q) 123·0. 121·2, 118·9, 112·0 96·3, 82·4; their common distance 12 inches; and, therefore, M *s* (or R *v*) 2 inches.



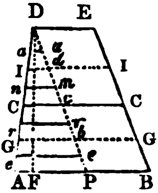
The area by Mr. Shirtliffe's rule, above cited, is 16399·69; the area by Mr. Moss's general rule, in the text, is 16409·33, the difference being about four one-hundredth parts of a gallon. In Moss's Gauging, page 257, &c., the operations are given at length, to show the vast advantage which the latter has over the former.

CONCLUDING NOTE BY MR. MOSS.

"It is manifest (by the writers on Fluxions) that the radius of curvature of a parabola is infinite at an infinite distance from its vertex; therefore the difference between a right-line and a parabolic curve of any kind, at an infinite distance from the vertex, is less than any assignable quantity; and, consequently, as the method here proposed (or those rules derived from the general principle) are strictly true, in every part of a parabolic curve, it evidently follows that, at an infinite distance from the vertex, the measure of a space obtained by any of these rules, will differ from that, when considered as a right-lined space, by a quantity less than any given or assignable quantity whatever; but (by Lemma 1st, page 99, of De L'Hospital's Conic Sections) if the difference of two quantities does continually diminish, so that at last it becomes less than any given quantity, then will those quantities at last be equal. Hence it is ends (if any,) calculated according to the foregoing rules, must be added.

---

evident that, by these methods, we can obtain the true (and not the approximate) measure of any rectilineal plane whatever; for any right-lined plane may be divided into quadrilaterals (whereof two sides must be parallel) and triangles; then may the true measures of those figures be separately found, by any assigned number of equidistant perpendiculars whatever; or the true area may be obtained by dividing the figure into triangles.



"Suppose, for example, it was required to find the measure of the right-lined space A B E D, when A B is parallel to D E and equal to 20, D E 12, and the perpendicular D F 30 inches.

1. *By three equidistant perpendiculars.*

| | |
|---|---|
| Sum of the extremes .................... | 32 |
| Four times the middle perpendicular (16) | 64 |
| | 96 |
| Multiplied by one-third of 15 ............ | 5 |
| Gives the required measure | 480 |

$\left(\frac{A\,B + D\,E}{2}\right) \times D\,F = 16 \times 30$; which is well known from other principles.

2. *By five equidistant perpendiculars.*

"If D P be drawn parallel to E B; and G G, C C, and I I be drawn parallel to A B, equidistant from one another, and the other dimensions the same as above, then it is evident that I *d* will be equal to 2, C *c* to 4, and G *h* to 6; whence D E will be 12, I I 14, C C 16, G G 18, and A B 20. Then, by the general rule,

| | |
|---|---|
| The sum of the two extreme perpendiculars ................ | 32 |
| Four times the sum of the 2nd and 4th perpendiculars ...... | 128 |
| Twice the sum of the rest (namely, the 3rd) ................ | 32 |
| | 192 |
| Multiplied by one-third of the common distance (7·5) ...... | 2·5 |
| Gives the content as before | 480·0 |

"Suppose, in the triangle A D P, A P 8, D F 30; which being divided into eight equal parts, and lines drawn parallel to the base, we shall have *a a* 1, I *d* 2, *n m* 3, C *c* 4, *r r* 5, G *h* 6, *e e* 7, and A P 8; whence, by cor. 2, page 103, we get $(\overline{1+3+5+7) \times 4+8+(2+4+6) \times 2} \times \frac{3\cdot75}{3} = 120$ $= (30 \times 4) =$ the area of the triangle A D P."—*Moss' Guaging*, p. 260, 26.

## PART III.—MENSURATION OF SOLIDS.

A **SOLID**, or body, has three dimensions, length, breadth, and thickness, or depth; and may be conceived to be formed by the motion or direct revolution of a superficies. As a plane or surface is bounded or terminated by lines, a solid, or body, is bounded or terminated by planes or surfaces.

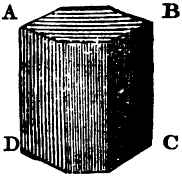
Solids are sometimes divided into regular and irregular. The regular solids are those which are terminated by regular and equal planes. The irregular solids are almost infinite, comprehending all such as do not come under the definition of regular solids. Those which are usually the subject of mensuration are the prism, the pyramid, the prismoid, the wedge, the sphere, the spheroid, the spindle, the conoid, and the various parts and sections of these bodies respectively.

The mensuration of a solid consists in ascertaining its capacity, or content. As in measuring surfaces, the simplest plane figure, which is a square, is taken for the measuring-unit, so, in measuring solids, the simplest solid, which is a cube, or figure bounded by six equal squares, is chosen for this purpose. When the length of one of the sides of the squares of a cube is one inch, the solid is called a cubic inch; when a foot, a cubic foot, &c. And the whole of the mensuration of solids consists in finding how many cubic inches, cubic feet, &c., are contained in a solid of any particular form.

The mensuration of solids is readily effected when the foregoing sections are fully understood. The simplest process is actual measurement, that is, dividing the given solid into a sufficient number of equal parts, each of which will exactly fill a measure which has been previously ascertained to hold just an inch, a pound, a bushel, or gallon, &c.; and the number of parts or measures into which the solid is thus divided, is the content or capacity thereof in inches, pounds, bushels, gallons, &c., according to the measure used. When the solid cannot be measured in this manner, the dimensions are taken in lineal measure, as in the case of superficies; and such dimensions are either reduced into cubic inches, and from thence, if necessary, into pounds, gallons, bushels, &c.; or, (when the operation is practicable,) they are reduced at once from lineal inches into pounds, gallons, bushels, &c., as may be required.

As a solid means either any body or the space which such body fills, so the surface of any solid may mean either the external surface of the body, or the internal surface of the space that surrounds it. Hence, in taking the dimensions of any body, it is of no importance whether they are taken internally or externally. Hence, also, it is evident that when a liquid or other substance is introduced into a vessel of the form of any particular solid figure, so as exactly to fill it, such substance will assume the form of the solid, and the measurement of the vessel, as a solid, will be the real measurement of the liquid or substance introduced, with the addition only of the thickness of the vessel; which must either be allowed for, in taking the dimensions, or deducted from the contents when the operation is completed. It will therefore be understood, that the following rules for finding the contents of bodies, usually apply as well to bodies that are absolutely solid in the popular sense of the term, as to the contents or capacity of any vessel of the same form as the bodies in question; the difference being, that in the former case, the dimensions are supposed to be taken externally, and in the latter, internally.

## 1. *Of Prisms.*

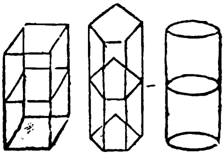


A PRISM is a solid with two ends or bases connected together by means of straight sides; as A B C D. The ends or bases may be plane figures of any form; but they are always equal, alike, and parallel to each other. The sides, or connecting surfaces, depend upon the figures of the bases. A prism may therefore be considered as generated by the motion of one of its bases, of whatever form it may be, descending always parallel to itself along a right-line.

Prisms receive particular names according to the form of their bases; as a *triangular* prism, a *square* prism, a *pentagonal* prism, a *hexagonal* prism, and so on. And hence the denomination "prism," comprises also the *cube*, (which, as a hexaedron, is considered as one of the five regular bodies,) and a *parallelogram*; the former being a

---

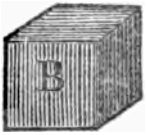
THEOREMS RELATING TO PRISMS.



1. Every section of a prism parallel to the base, is equal and similar to the base.
2. All prisms standing on equa bases, and having the same altitudes, or being between the same parallels, are equal to each other.
3. Similar prisms and, generally, all similar solids are to each other as the cubes of their altitudes, or of any of their like lineal dimensions, or in the triplicate ratio of their like sides.
4. A parallelopipedon and a cylinder having equivalent bases and the same altitude, are equal to one another.
5. The superficial content, or area, of a prism, is the area of the two ends and of the sides added together.

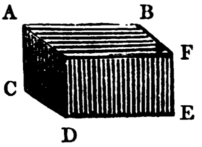
OF THE FRUSTUMS OF PRISMS.

A *frustum* is a part cut by a plane parallel to the base; hence, a frustum of a prism is a prism, only of a less depth than the prism from which it was cut, as will be obvious from the Theorems 1, 2, and 3, and the figures illustrating them. Therefore, *as the axis of the whole prism is to its* square prism, and the latter a rectangular one. And even a *cylinder* may be considered as a round prism, or one that has an infinite number of sides. A prism is likewise said to be *regular* or *irregular*, according as the figure of the base is a regular or irregular polygon. A prism, again, is either *right* or *oblique*. A *right* prism is that whose sides and axes are perpendicular to its ends, like an upright tower; and an *oblique* prism is when the axis and sides are oblique to the ends, so that, when set on one end, it inclines on one hand more than on the other.



A *cube* is bounded or comprehended by six equal sides; as B.

A *parallelopipedon* is bounded by six parallelograms, every opposite two of which are equal, similar, and parallel; as A B C D E F; and when the bounding parallelograms are right-angled and perpendicular to each other, it is called a *rectangular parallelopipedon.*



---

*content, so is any part of its axis to the content of the frustum or part cut off.* Thus, if we want to cut off 8 inches from the top of a cylinder, parallel to the base, the original depth being 24, and its content 17280 inches, we have only to say,

As 24 : 17280 : : 8 : 5760, the solidity of the less frustum.

And as 24 : 17280 : : 16 : 11520, the solidity of the greater.

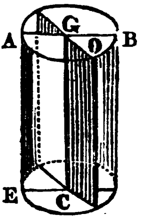
Again, *as the solidity of the whole cylinder is to its axis, so is the solidity of any frustum or part cut off to the axis of that part.* Thus, if a cylinder be of the depth of 80 inches, its diameter 75, and its solid contents, therefore, 1274·656 gallons, and it be required to cut it parallel to the bottom, at such a distance that it may contain 940 gallons only, we say,

As 1274·656 : 80 : : 940 : 58·99 inches, the distance required.

This may easily be proved by finding the depth, or axis of the part cut off, the content of it being 1274·656 — 940 = 334.656; then,

As 940 : 58·99 : : 434·656 : 21·01, the depth of the part cut off; which being added to 58·99, the depth of the remaining part, will give 80, the whole depth of the vessel before it was cut.—*Jones's Gauger.*

A *cylinder* may be conceived to be generated by the revolution of a right-angled parallelogram (as G C O) about one of its sides, (as G C,) which remains fixed; its bases, or ends, being two equal and parallel circles; and its diameter of an equal thickness, or length, in all its parts.



---

### OF THE UNGULAS OF PRISMS.

An *ungula*, or *hoof*, is any part cut off not parallel to the base. As the liquids in casks and other circular vessels sometimes assume one or other of these forms when placed in an inclined position, the following rules for ascertaining the contents may be found useful. They are more particularly applicable to cylinders, but the principles upon which they are founded are common to prisms of every description.

Fig. 2.

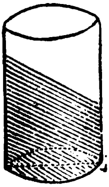


Fig. 3.

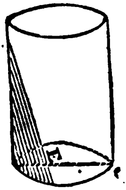


Fig. 4.

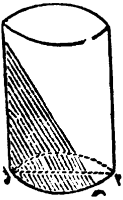


Fig. 5.

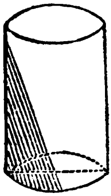
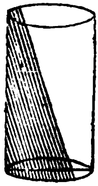


Fig. 6.



I. *When the section is parallel to the axis of the prism*, (see fig. 1,) multiply the area of the base of the ungula by the height of the prism.

II. *When the section passes obliquely through the opposite sides of the prism*, (see fig. 2,) multiply the area of the base of the prism by half the sum of the greatest and least lengths of the ungula.

III. *When the section passes through the base of the prism and one of its sides*, (see fig. 3,) find the area of the base of the ungula as the segment of a circle, (see p. 92,) and multiply it by the difference between the radius of the prism and versed-sine or height of the ungula's base, and add the product to one-twelfth of the cube of the chord of the base, if the height of the base be greater than the radius, as in fig. 4, otherwise, (as for fig. 3,) subtract them; multiply the sum or difference, as the case may be, by the height of the ungula, and divide the product by the height of the base.

If the base of the ungula be an exact semicircle, (as in fig. 5,) multiply the square of the diameter of the prism by the height of the ungula, and divide the product by 6.

IV. *When the section passes obliquely through both ends of the prism*, (see fig. 6,) find the solidity of each of the ungulas by case III., and their difference will be the solidity required.

The *axis* of a prism is a line conceived to be drawn lengthwise through the middle of it, connecting the centre of one end with that of the other end; and the *frustum* of a prism, is any part thereof cut off parallel with the base.

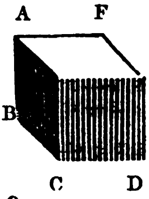
TO FIND THE CONTENT. RULE I.*—Multiply the

---

* This rule has been partly anticipated in the Mensuration of Superficies, wherein, instead of taking surfaces as being of no depth or thickness, as in strictness they are not, they have been taken as if they were of the thickness of an inch; so that the calculation in each case gave at once the areas of the superficies and also the content of similar solid bodies whose bases were one inch thick; and such area or content only required to be divided by the number of cubic inches contained in a foot, pound, gallon, or bushel, to give the content in those denominations respectively. If, instead of one inch, the solid be two or any number of inches thick or high, it is obvious that we have only to multiply the superficial content or area, found as above, by the number of inches which the solid is thick or high, to obtain the whole content of the prism.

### EXAMPLES OF THE CUBE.

(1.) If the side of a cube, A B C D F, be 40 inches, what is the solidity?

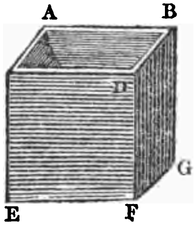


BY RULE I.

| | |
|---|---|
| Length .............. | 40 |
| Breadth.............. | 40 |
| Area of the base .... | 1600 |
| Depth.... .......... | 40 |
| Solidity in inches .... | 64000 |

| Then (See p. 31,) | Or, |
|---|---|
| 64000 ÷ 277·274 = 230·8 gallons. | 64000 × ·0036065 = 230·8 gallons. |
| 64000 ÷ 2218·192 = 28.85 bushels. | 64000 × ·0004508 = 28·85 bushels. |

(2.) Each side of a cubic malt couch, A B G F E, is 40 inches, what is its content?



BY RULE II.

| | |
|---|---|
| The area of the base, by multiplying the length and breadth, is 1600 inches = ·72125 bushels. | |
| Depth...................... | 40 |
| Content...................... | 28.85 bushels. |

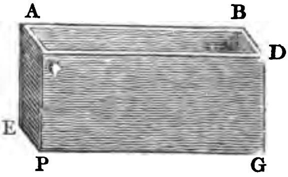
These rules, as applied to cubes, are only, in effect, the converse of extracting the cube-root. (See page 20.) Therefore to find the side of a cube, the solid content being given, we have only to extract the cube-root thereof, area of the base by the perpendicular height in inches; the product will be the content in inches; which may be

---

the same being first reduced to cubic inches, if necessary. If it be required to find the content of a solid in cubic feet, it will only be necessary to multiply the content in solid inches, found as above, by ·000578, the square factor for a solid foot (see the Table of Factors, &c., page 57); or to divide the content in solid inches by 1728, the square divisor for a solid foot (see the same Table); the product or quotient, as the case may be, will be the content in cubic feet.

EXAMPLES OF THE PARALLELOPIPEDON.

(3.) Let the length, A B, of a vessel in the form of a parallelopipedon, be 45 inches, the breadth, A C, 15 inches, and the depth, A E, 12 inches; what is the content in gallons and bushels respectively.



BY RULE I.

| | |
|---|---|
| Length ............ | 45 |
| Breadth .......... | 15 |
| Area of the base .. | 675 |
| Depth ............ | 12 |
| Solidity in inches .. | 8100 |

Then (See p. 31,)

8100 ÷ 277·274 = 29·213 gallons.

8100 ÷ 2218·192 = 3·651 bushels.

or,

8100 × ·0036065 = 29·213 gallons.

8100 × ·0004508 = 3·651 bushels.

BY RULE II.

The area of the base found by multiplying the length by the breadth, as in page 80, is 675 inches = 2.4344 gallons.

| | | |
|---|---|---|
| Depth ...... | 12 | |
| Content...... | 29·2128 | gallons. |

Or, 675 inches = ·3043 bushels.

| | | |
|---|---|---|
| Depth ........ | 12 | |
| Content ...... | 3·6516 | bushels. |

The same result would be obtained if a mean proportional between any two of the three dimensions were found, and such mean (reduced to gallons or bushels) multiplied by the remaining dimension. This is rather a tedious process by the ordinary mode of working; but as a mean proportional can easily be obtained and squared on the sliding-rule, that instrument is usually employed for this purpose. But a beautiful and much more expeditious method of finding the solid content of prisms is adopted, when such content is required to be found in bushels, by a line on the sliding-rule marked M D, as will be more particularly explained in the next chapter. This is peculiarly applicable to the gauging of malt, which is usually placed in vessels or heaps of the form of a parallelopipedon, and it is therefore important that the reasons for the operations should be well understood. An error is sometimes committed by adding the breadth and depth together, and taking half the sum of the side of a square, instead of either multiplying the length and breadth together, or finding a mean proportional between them. This error ought to be carefully avoided.

reduced into any other denomination by the proper divisors or factors.

---

**An easy method of obtaining the contents of solids of this description, is by the Table of Semi-Squares, *infra*, the rule for which is as follows :— From the sum of the tabular length and breadth, subtract the tabular difference between them ; multiply the last difference by the real depth, and the product will be the content. (And see pages 89, 99.) Thus, for the last example, we have,**

Opposite to the length, ....45 3·6516
Opposite to the breadth,....15 ·4057
— 4·0573 Snm.
Opposite to their difference, 30 1·6229
2·4344 Diff.
Depth........................ 12
Content in imperial gallons .. 29.2128 as before

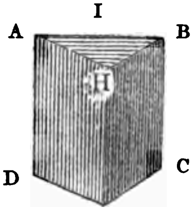
(3.) One of the equal sides of a square-bottomed vessel is 135 inches, and its depth, or height, is 40 inches ; what is the content.

Opposite to the length, 135, is 32·8646 × 2 = 65·7292
Depth .................................. 40
Content in imperial gallons .................. 2629·1680

In this example the breadth is the same as the length, and the difference is 0 ; hence the reason of simply multiplying by 2.

EXAMPLES OF THE TRIANGULAR PRISM.

(4.) One side of the base of a triangular prism, AB, is 63, the perpendicular on AB, from H, is 14, and the height, A D, is 80 inches ; what is the content in gallons ?



BY RULE I.
A B .. 63
½ of H I 7
441
A D 80
35280 cubic inches = 127·238 gallons, see the Table, page 53.

BY RULE II.
63 × 7 = 441 in. = 1·59046 gallons.
80
Content 127·2368 gallons.

The content of a triangular prism may also be found by the Table of Semi-Squares. Thus, taking the above example, we have,

Opposite to A B, ...... 63 inches 7·15718
Opposite to H I, ...... 14 ...... ·35344
— 7·51062 Sum.
Opposite to their difference 49 ...... 4·32965
Diff. 3·18097 ÷ 2 = 1·59048

which multiplied by the height A D = 80 ; gives 127·2384 gallons, the content as before.

RULE II.—Find the area of the base in gallons or bushels, either by calculation, according to the foregoing

---

EXAMPLE OF AN HEXAGONAL PRISM.

(6.) Let A B C D E F G be a prism, with a regular hexagonal base, the side of the base being 40 inches, and the depth of the vessel 32 inches; required the content in gallons.

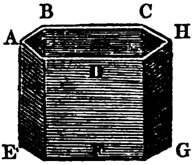
The tabular number for hexagons (see the table, *infra*) is 2·9580762 inches = ·0010668 gallons.

$40^2$ = 1600

1·70688

Depth .................... 32

Content in gallons ........ 54·62016



EXAMPLE OF A PENTAGONAL PRISM.

(7.) What is the solidity, in gallons, of a pentagonal prism whose length is 60 inches, and each side of its regular end is 20 inches?

The area of a pentagon whose side is 1 is 1·7204774 (see the table, *infra*); hence, by page 83, we have 1·7204774 × $20^2$ = 688·19006 area of the base, or end; and therefore 688·19096 × 60 = 41291·4576 inches = 148·92 gallons.

EXAMPLES OF THE CYLINDER.

(8.) What is the solidity of a cylinder, A B C D, whose diameter, A B, is 21·5 inches, and the depth, A C, 40 inches?

BY RULE I.

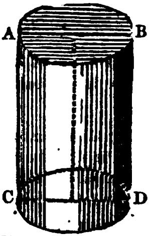
Constant decimal ........ ·7854 (see p. 90.)

21·5×21·5 = 462·25

Area of the base .......... 363·05115

Depth .................... 40

14522·046 inches.



Then (See p. 31,)

14522·046 ÷ 277·274 = 52·374 galls.

14522·046 ÷ 2218·192 = 6·547 bushls.

or

14522·046 × ·0036065 = 52·374 galls.

14522·046 × ·0004508 = 6·547 bushls.

BY RULE II.

21·5 × 21·5 × ·7854 = 363·05115 = 1·30936 gallons.

Depth ........ 40

Content ...... 52.3744

An easy method of finding the content of a cylinder, is by the sliding-rule, as will be explained under the head of "Gauging;" but the readiest way of finding such content, is by means of the Table of Circular Areas, *infra;* thus, in the foregoing example,

Opposite the diameter 21·5 is...... 1·3094

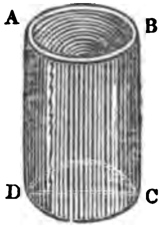
Depth .......................... 40

Content = 52·376 galls., as before.

The importance of properly understanding the measurement of the cylinder, will be appreciated when it is recollected that, in gauging, casks of different descriptions are generally reduced to this form before the contents are obtained.

rules, or by reference to the proper tables; multiply such area by the perpendicular height, and the product will

---



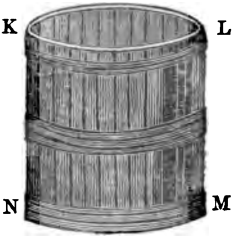
**(9.) Let A B C D be a cylindrical vessel, the diameter, A B, being 38 inches, and the depth, B C, 60 inches; the content is required in gallons.**

**BY RULE I.**

**38 × 38 × ·7854 = 1134·1176, the area of the base; then 1134·1176 × 60 = 68047·056 inches = 245·414 gallons.**

**Or thus:**

**The area of a circle whose diameter is 38 (see the Table of circular areas) is 4·0902**
**Depth .............................. 60**
**Content of vessel .................... 245·412**



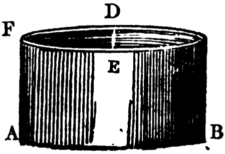
**(10.) Suppose the cylinder K L M N be intended to contain a fluid, and that the sides and bottom are each one inch in thickness; how many imperial gallons would it hold, the exterior diameter, K L, being 402 inches, and depth, K N, 541 inches?**

**BY RULE II.**

**Here 402 — 2 = 400 inches, the interior diameter; and 541 — 1 = 540 inches, the internal depth.**

**Then $400^2$ × ·7854 = 125664 inches = 453·2112 gallons.**
**Depth .......................... 540**
**Hence the cylinder will hold .... 244734·66 gallons.**

**EXAMPLE OF AN ELLIPTICAL PRISM.**



**(11.) Let A B C D E F be a vessel in the form of an elliptical prism, or cylindroid, that is, having equal and parallel ellipses for ends, and its sides perpendicular to them; let the depth, A F, or B C, be 50 inches, the transverse axis, F C, or A B, 154 inches, and the conjugate axis, D E, 55 inches, required the content in gallons.**

**BY RULE II.**

$$\text{Here } \frac{154 \times 55 \times \cdot 7854}{277 \cdot 274} = 23 \cdot 992 \text{ gallons, nearly.}$$

**50 Depth.**

Content of the vessel 1199·6 gallons.

be the content in gallons or bushels, as the case may be.

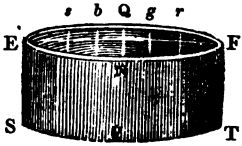
---

The area of an ellipsis is a geometrical mean proportional between the areas of two circles described on its transverse and conjugate diameters; (see page 99,) and therefore its area may be obtained by the Table of Circular Areas, *infra*, by the same method as that used for a rectangle with the Table of Semi-Squares; with this difference only, that the result must be divided by 2, since the table employed is not a table of semi-circles, but of complete circles. Thus, taking the example above, we have,

| | | | |
|---|---|---|---|
| Opposite to transverse .... | 154 | 67·1772 | |
| Opposite to conjugate .... | 55 | 8·5685 | |
| | | 75·7457 | Sum. |
| Opposite to their difference | 99 | 27·7620 | |
| | | 2 ) 47·9837 | Difference. |
| Content of elliptic base........ | | 23·9918 | gallons. |
| Depth ........................ | | 50 | |
| Content of elliptic prism ...... | | 1199·590 | gallons. |

By this method, the contents of elliptic vessels may be computed with great facility, and it should be universally adopted in preference to any other when the two bases are true ellipses, and equal, and the sides exactly perpendicular.

### EXAMPLE OF AN IRREGULAR PRISM.



(12.) Let E F T S be an irregular curved vessel, with upright sides, the height of which is 70 inches; and the dimensions of the base, taken according to the rules for perpendicular ordinates, (page 108, &c.,) are as follows:—longer axis, E F, 112, Q N 80, *s* 70, *b* 79, *g* 78·6, *r* 69, the common distance of each being 24, and therefore the axis of each segment, 8; what is the area in gallons?

### BY RULE II.

The dimensions of the base being the same as in example 3, page 107, the area, found according to the calculations there given, is 8176·53 inches,

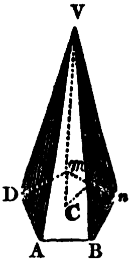
Then 8176·53 ÷ 277·274 = 29·48899 Area of the base in gallons.

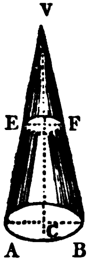
| | |
|---|---|
| Depth in inches .. | 70 |
| Content in gallons | 2064·2293 |

If there be the least deviation from the perpendicular in any part of the sides of the vessel, (which can only be ascertained by a sufficient number of admeasurements, and the use of a plumb-line, &c.,) a different mode of calculation must be adopted. (See "Prismoids," "Gauging," &c., *infra*.)

## 2. *Of Pyramids and their Frustums.*

A PYRAMID is a solid standing on a base of any form, and terminated in a point at the vertex. Like the prism, it takes particular names from the figure of the base; as a *square* pyramid, a *triangular* pyramid, a *pentagonal* pyramid, as A B V (fig. 1), &c. A *cone* may also be considered as a pyramid, having for its base a regular polygon of an infinite number of sides. If the perpendicular from the vertex falls on the centre of the base, the solid is called a *right* pyramid, but if not, it is *oblique*.





A *cone*, as A B V, (fig. 2,) may be conceived to be

---

THEOREMS RELATING TO PYRAMIDS, &c.

1. All pyramids and cones of equal bases and altitudes are equal to one another.

2. The surfaces of similar right cones are as the squares of the axes; and their solid contents are as the cubes of the axes.

3. The convex surface of a pyramid is equal to half the product of its slant height by the circumference of the base; to which the area of the base must be added for the whole surface.

4. A pyramid, a triangular prism, and a parallelopipedon (see p. 115) standing upon the same base, and having the same altitude, are to one another as 1, 1½, and 3. Hence, also, a cone is equal to the third-part of a cylinder of equal base and altitude.

5. In any pyramid, a section parallel to the base is similar to the base; and these two planes are to each other as the squares of their distances from the vertex.

6. The surface of the frustum of a cone consists of the areas of the two ends, together with the product of half the sum of the perimeters of the two ends and the slant height.

7. The slant height and perpendicular height of a frustum whose ends are regular polygons, are two sides of a right-angled triangle, the base of which is equal to the difference between the radii of the inscribed circles of the two ends of the frustum.

described by the revolution of a right-angled triangle about one of its legs, which remains fixed. Sections made by the cutting of a cone in different ways, called *conic sections*, have already been mentioned. (See pages 95 and 96.)

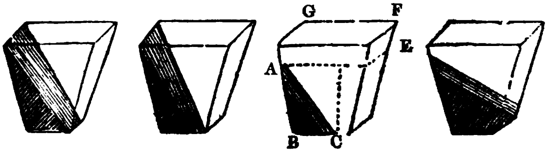
The *altitude* of a pyramid is a straight line drawn from

---

### OF PYRAMIDICAL AND CONICAL UNGULAS.

The liquor in pyramidical vessels, when placed in an inclined position, sometimes assumes the form of an *ungula*, or *hoof*, (being any part cut off without being perpendicular to the base,) of a square pyramid, or a cone, or of the *frustum* thereof. The following rules for finding the contents may therefore be useful.

PYRAMIDICAL UNGULAS.



I. *When the liquor just covers the whole of the bottom, and rises to the top in an oblique direction*, (see fig. 1.) This ungula is evidently a *wedge*, and the content must be found by the proper rule, *infra*.

II. *When the liquor covers only part of the vessel and rises to the top*, (see fig. 2.) This ungula is also a wedge, and must be measured in the same way as before, the base being considered to be that part of the liquor only which covers the bottom. The empty part of the vessel will, in this case, be a *prismoid*, the content of which may be found by the proper rule, *infra*.

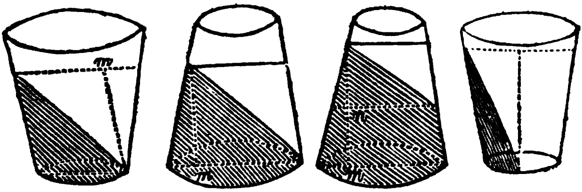
III. *When the liquor covers only part of the bottom, and does not rise to the top of the vessel*, (see fig. 3.) In this case, likewise, the ungula (as A B C) is a wedge, and must be measured accordingly. The empty part will then be composed of the prismoid A C D E and the *pyramidical frustum* A E F G. If the vessel be a prismoid, both these figures will be prismoids.

IV. *When the liquor intersects obliquely the opposite sides of the vessel*, (see fig. 4.) In this case, if the vessel be the frustum of a square or rectangular prism, the ungula disposes itself into the form of a wedge and the frustum of a pyramid; and the contents of each part must be found separately and added together for the content of the ungula. The empty part of the vessel will, in this case, be composed of a wedge and a frustum.

When the vessel, intersected in the manner last supposed, is a prismoid, the liquor disposes itself into the form of a wedge and a prismoid.

the vertex to the base or plane on which it stands; as V C. And the *slant height* is a straight line drawn from the vertex to the outer edge of the base; as V A.

CONICAL UNGULAS.



I. *When the liquor just covers the whole of the base or bottom of the vessel, and rises to the top.* If the frustum stands upon its greater base, (as in fig. 1,) multiply the product of the top and bottom diameters of the vessel by the mean proportional between them; subtract the last product from the cube of the bottom diameter; divide the remainder by the difference of the diameters; multiply the quotient by the perpendicular height of the ungula, and the product thence arising by ⅓ of the proper circular factor (see page 91). If the frustum stands upon its less base, (as in fig. 2,) the process will be exactly the same, except that the cube of the bottom diameter must be subtracted from the product above mentioned, instead of the product being subtracted from the cube.

II. *When the liquor covers the base, but does not rise to the top of the vessel,* (see fig. 1 and 2,) proceed as in case 1, taking for the top diameter the diameter at the upper extremity of the liquor measured parallel to the top of the vessel.

III. *When the liquor intersects opposite sides of the vessel,* (as in fig. 3,) it evidently forms the frustum of a cone and an ungula, and the contents must be found separately and added together; or the content of the empty ungula may be found and subtracted from the content of the frustum for the content of the other part.

IV. *When the liquor only covers a part of the base,* find the tabular area answering to the quotient of the height of the base by its diameter, and multiply it by the cube of that diameter for the first content; also, from the height of the base, subtract the difference between the diameters of the top and the base of the hoof; and take the tabular area answering to the quotient of the remainder divided by the diameter at the top, and multiply it by the cube of the diameter at the top, and by the quotient of the height of the base divided by the said remainder and by the square-root of the same quotient for another content; multiply the difference of these contents by one-third of the height of the hoof; and the product, divided by the difference of the diameters, will give the content of the under hoof; and this hoof, subtracted from the content of the frustum, will give the other hoof.—*Ingram's Mensuration*, page 167.

A *segment* is a part cut off from the top by a plane parallel to the base, as V E F, (fig. 2.) A *frustum* is the part remaining after the segment or top is removed, as A B E F.

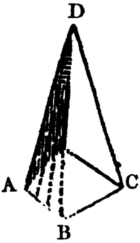
TO FIND THE CONTENT OF A PYRAMID OR CONE.*

RULE I.—Multiply the area of the base, in inches, by one-third of the perpendicular height; the product is the

---

* EXAMPLES OF A SQUARE PYRAMID.

(1.) Required the content of a square pyramid, the side of the square, AB, being 22 inches, and the height 30 inches.



BY RULE I.

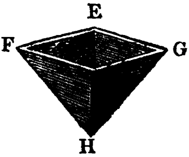
$22 \times 22 \times \frac{30}{3} = 4840$ inches = 17·45546 gallons.

BY RULE II.

22 × 22 = 484 = 1·74554 gallons.
⅓ of depth 10
Content 17·4554 gallons.

The same result would be readily obtained by the Table of Semi-Squares, *infra*. Thus,

(2.) Let the depth be 30 inches, and the side of the base, E F, 22 inches, as before; what is the content in gallons?

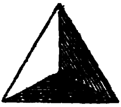


Opposite to 22 we find ·8728.

Then ·8728 × 2 = 1·7456 Area of the base.
⅓ of the height.. ...... 10
Content of the pyramid 17·456

EXAMPLE OF A TRIANGULAR PYRAMID.

(3.) What is the content of a triangular pyramid, the perpendicular height being 40 inches, and the sides of the base 20, 24, and 30 inches?



BY RULE I.

The area of the base (see page 77) is 39·246.

Hence $293{\cdot}246 \times \frac{40}{3} = 3189{\cdot}94$ cubic inches = 11·5 gallons, nearly.

An equilateral triangular pyramid is a *tetraedron*, one of the five regular bodies, and its content may be found by multiplying the cube of one of its sides by 0·11785. (*See post.*)

content in inches, which may be reduced to gallons or bushels by the proper divisors or factors.

Rule II.—Find the area of the base in gallons or bushels, by calculation or by reference to the proper tables; multiply such area by one-third of the perpendicular depth or height in inches; the product will be the solidity in gallons or bushels, as the case may be.

---

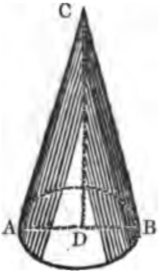
### EXAMPLE OF A PENTAGONAL PYRAMID.

(4.) Let A B, (fig. 1, p. 123,) the side of the pentagonal base, be 20 inches, and V C, the height, be 75 inches; what is the content?

Constant factor for pentagons 1·720477 (see page 84.)
$20^2 =$ 400
Area of base ........ 688·1098 in. = 2·482 gals.
One-third of 75, the depth 25
Content of the pyramid.... 62·05 gals.

### EXAMPLES OF A CONE.

(5.) Let the diameter, A B, be 60 inches, and the depth, C D, 108 inches; what is the content in gallons?



BY RULE I.

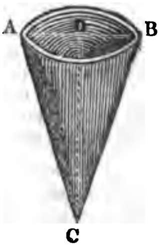
$60 \times 60 \times \cdot 7854 = 2827 \cdot 44$ Area of base.
$\frac{1}{3}$ of the depth 36
Content ...... 101787·84 cubic inches.
And $101787 \cdot 84 \div 277 \cdot 274 = 367 \cdot 1019$ gallons.

BY RULE II.

$60^2 \times \cdot 7854 = 2827 \cdot 44 = 10 \cdot 1973$ gallons.
$\frac{1}{3}$ of depth .......... 36
Content ............ 367·1028

BY THE TABLE OF CIRCULAR AREAS.

Opposite to the diameter, 60, in the Table of Circular Areas, *infra*, is 10·1973, which, multiplied by 36, or one-third of the depth, gives the content 367·1028 gallons, as before.



(6.) What is the content of a heap of malt in the form of a cone, the diameter of the base being 260, and the depth, or perpendicular height, 120 inches? Ans. 119·301 bushels.

(7.) Required, the content in gallons of a conical vessel, the diameter, A B, being 38 inches, and the depth, or height, C D, 45 inches.

Ans. 61·35 gallons.

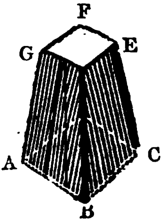
TO FIND THE CONTENT OF THE FRUSTUM OF A PYRAMID.* RULE I.—To the sum of the areas of the two ends add their geometrical mean (that is, the square-root of the product of the two areas); multiply the sum

---

* EXAMPLES OF THE FRUSTUM OF A SQUARE PYRAMID.

The mean proportional of the areas of the ends of the frustum of a square pyramid is equal to the product of the sides of its greater and less base; hence Rule I., so far as regards frustums of square pyramids, may be expressed in other words, as follows:—To the rectangle of the sides of the two ends, add the sum of their squares; that sum being multiplied into one-third of the frustum's height, will give the solidity.

(8.) What is the content of the frustum of a square pyramid A B C E F G, when A B = 30, E F = 20, and the depth 42 inches?



BY RULE I.

$30^2 + 20^2 + 30 \times 20 = 900 + 400 + 600 = 1900$

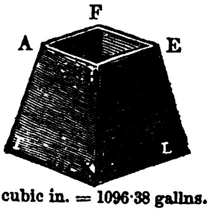
⅓ of the depth.... 14

Content in inches 26600

And 26600 ÷ 277·274 (see p. 31) = 95·933 galls.

Or, 26600 × ·0036065 = 95·933 galls, as before.

(9.) What is the content of the frustum of a square pyramid, the sides of the bases being I K = K L = 60 inches, and A I = E L = 40 inches, and the height, or depth, 120 inches?



BY RULE II.

$A B\ 60 + D E\ 40 = 100^2 = 10000$

$60 - 40 = 20^2 = 2400$

7600 × 40 = 304000 cubic in. = 1096·38 gallns.

The tabular-number of a square being 1, does not require multiplication.

Another mode of finding the content of a frustum is the following:—Find the whole length of the pyramid thus,—as the difference of the breadths of the two ends is to the length between them, so is the breadth of the less end to the length of the part cut off; then find the content of the whole pyramid and the content of the top part, and subtract the top from the whole; the remainder will be the content of the frustum.

EXAMPLE OF THE FRUSTUM OF A TRIANGULAR PYRAMID.

(10.) Required the content of the frustum of a triangular pyramid, the height of the frustum being 14 inches, the sides of the greater base 21, 15, and 12, and those of the lesser base 14, 10, and 8 inches.

by one-third of the frustum's perpendicular height; and the product will be the content in inches, which may be reduced to gallons or bushels in the usual manner.

**Rule II.**—If the base be a circle or a regular polygon, add a diameter or a side of the greater base to one of the less, and from the square of the sum subtract the pro-

---

BY RULE I.

The areas of the bases are $36\sqrt{6}$ and $16\sqrt{6}$, and the square-root of their product is $24\sqrt{6}$; therefore $(36\sqrt{6} + 16\sqrt{6} + 24\sqrt{6}) \times \frac{1}{3} \times 14 = 868{\cdot}7523621$ cubic inches, the content.—*Ingram's Mensuration.*

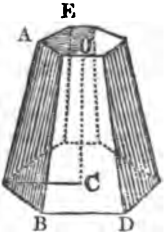
EXAMPLE OF THE FRUSTUM OF AN HEXAGONAL PYRAMID.

(11.) What is the content of the frustum of an hexagonal pyramid, one side of the base, B D, being 20 inches, one of the sides at the top, A E, 15 inches, and the depth, O C, 36 inches?

BY RULE I.

$$\begin{array}{rlr}
 & \text{Factor for hexagons (see page 84)} & 2{\cdot}5980762 \\
 & \text{Multiply by} & 925 \\
20^2 = 20 \times 20 = 400 & & \overline{\phantom{0000000}} \\
15^2 = 15 \times 15 = 225 & & 2003{\cdot}220485 \\
20 \times 15 = \underline{300} & \frac{1}{3}\text{ of depth} & \underline{12} \\
\underline{925} & \text{Cubic inches} & \underline{24038{\cdot}64582}
\end{array}$$

which may be reduced to gallons or bushels in the usual manner.

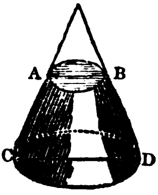


EXAMPLES OF THE FRUSTUMS OF A CONE.

(12.) What is the content of the frustum of a cone, A B C D, the diameter at the base, C D, being 20 inches, diameter at the top, A B, 12 inches, and the depth, 36 inches.

BY RULE I.

$$\begin{array}{rr}
 & 20^2 = 400 \\
 & 12^2 = 144 \\
 & 20 \times 12 = \underline{240} \\
 & 784 \\
\text{Depth} & \underline{36} \\
 & \underline{28224} \times {\cdot}2618 = 7389{\cdot}0432 \text{ inches.}
\end{array}$$

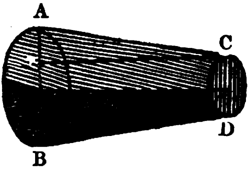


Then $7389{\cdot}0432 \times {\cdot}0036065 = 26{\cdot}648$ galls.; and $26{\cdot}648 \div 8 = 3{\cdot}331$ bushels.

Here, instead of finding the areas of the two ends, and their geometrical mean, separately, as directed by the rule, the calculation is made as if the bases were squares, and the vessel cylindrical; and a factor is used at duct of those diameters or bases; the remainder, multiplied by the proper tabular-number belonging to the figure, and by one-third of the height, will give the content.

---

the end (·2618, being $\frac{1}{3}$ of ·7854, see page 90) which produces the same result as if the areas were found separately, and multiplied by one-third of the height.



(13.) Suppose a conical frustum to have its greater diameter, A B, 20 inches, its less diameter, C D, 12 inches, and its length 360 inches; what is its content?

BY RULE II.

$20 + 12 = 32 \times 32 = 1024$

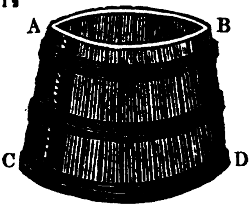
$20 \times 12 = 240$

$784 \times ·7854 \times 120 = 73890·432$ inches.

Instead of multiplying by ·7854 and one-third of the height, it would have been the same thing if the sum (784) had been multiplied by the *whole* length, and by the factor mentioned above (·2618).

The contents of a conic frustum may also be found by the Table of Circular Areas, *infra*, as follows:—

To the area of a circle whose diameter is equal to the sum of the top and bottom diameters of the frustum, add $\frac{1}{12}$ of the area of a circle whose diameter is the difference of the aforesaid diameters; multiply the sum by the height or depth, and the product will be the content in gallons.



(14.) What is the content of the frustum of a cone A B C D, the top diameter, A B, being 60·2 inches, the bottom diameter, C D, 98·5 inches, and the depth 82·8 inches?

$98·5 + 60·2 = 168·7$, opposite to which is $71·3402 \div 4 = 17·8350$

$98·5 - 60·2 = 38·3$ .................... $4·1551 \div 12 = ·3463$

18·1813

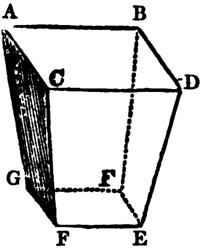
Depth.......................... 82·8

Content 1505·41164 gals.

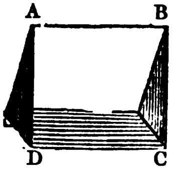
The above example shews the facility of this mode of working, which, as a check, should be used by the practical gauger in preference to any other method.

When two conical frustums are joined at the thick end of each frustum they constitute a figure which, by gaugers, is called a cask of the fourth variety, the content whereof may be found by a double application of either of the foregoing rules. Such a figure, however, is rarely met

### 3. *Of the Prismoid and Wedge.**



A Prismoid, as A B D E F G, is a solid somewhat resembling a prism, but its ends are any dissimilar parallel plane figures of the same number of sides, the upright sides being trapezoids; or the sides may be any dissimilar curves, in which case it is sometimes called *a cylindroid.* A prismoid may, therefore, be considered to comprehend all solids, (not included in the foregoing sections,) which have two parallel bases, and the greatest and least thicknesses of which are at the ends.



A *wedge*, as A B C D, is a solid with a rectangular base, and two of its opposite sides terminating in an edge. It may be otherwise defined to be one half of a prism, or prismoid, of equal base and length.

---

with in practice, the usual shapes of casks and tubs being more spheroidal; that is, they have an arched or swelling course from the middle, or bung, to the chine, or end. (See post tit. "Spheroids, Conoids, and Spindles;" "Cask Gauging," &c.)

* THEOREMS RELATING TO PRISMOIDS.

1. The ends and sides of a rectangular prismoid consist of trapezoids and parallelograms.

2. A rectangular prismoid is evidently composed of two wedges, whose heights are equal to the height of the prismoid, and their bases its two ends.

THEOREMS RELATING TO WEDGES.

1. The base of a wedge is a right-angled parallelogram; the two ends are triangles, and the two sides parallelograms or trapezoids.

2. If the edge is shorter or longer than the base, it is so much greater or less than half a prism by a pyramid of the same height and breadth at the base with the wedge, and the length of whose base is equal to the difference of the length of the edge and base of the wedge.

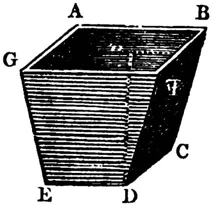
TO FIND THE CONTENT OF A PRISMOID.* 1.—To the length or transverse diameter of the greater base add half of the length or half of the transverse diameter of the lesser base, and multiply this sum by the breadth of the greater base, which product note down. 2.—To the length or transverse diameter of the less add half of the

---

* The above rules are of great importance in practical gauging. Rule I. is adopted in *Gutteridge's Gauger* as sufficient to "find the content of a vessel either of four sides or curved, the sides whereof are straight from top to bottom, whether the bases are equal or unequal; alike or unlike; proportional or disproportional; alike situated or inverted; the one base a square, the opposite one a parallelogram; or the one an ellipsis and the opposite one a circle." And as to Rule II., it is shewn in *Hutton's Mensuration*, (quarto edition,) that it is true for all frustums whatever, and for all solids whose parallel sections are similar figures. And Moss, in his Gauging, p. 175, (third edition,) says that it is nearly true, let the form of the solid be what it may. He, however, recommends the rule for equidistant ordinates to be used, for finding the areas, when the bases are irregular. Alluding to a rule somewhat similar to Rule I., he observes, "Some authors have asserted that the same rule which gives the content of a prismoid, will also hold good in any straight-sided vessel whose parallel ends are dissimilar ellipses, and any how posited. But it appears that this assertion is without proper foundation, and seems to have arisen wholly from the following supposition, viz. 'if in any prismoid, another straight-sided vessel (or solid) be inscribed, whose ends are ellipses, the transverse and conjugate diameters of each respectively equal to the lengths and breadths of the said prismoid; that then the sections parallel to the ends of such a solid will also be ellipses.' But that this cannot be the case the preceding note will (I make no doubt) sufficiently convince every judicious reader. It may, however, be proper to observe that the content of a tun of this form may be obtained with the greatest expedition by the general rule derived from the property of equidistant perpendiculars, &c., and the result will be sufficiently exact if the section in the middle be considered an ellipsis. For the said rule is *strictly true* in every *straight-sided* vessel, provided the measure of the two ends and that of a parallel section in the middle can be truly determined." (See pp. 101—111, and the example in p. 134, &c.)

EXAMPLES OF A PRISMOID.

(1.) Required the content in gallons of a four-sided figure whose opposite sides are equal and parallel at each base; the longest side at the greater base, A B, 30, the shorter, B F, 20 inches; the opposite ones, D E, 20, and D C, 10 inches, and the depth, B C, 30 inches.



length, or half of the transverse diameter of the greater base, and multiply the sum by the breadth of the lesser base. 3.—Add the two sums found as above, and multiply the total by one-third of the depth; and then, by employing the proper square divisor, if the vessel be

---

BY RULE I.

$$\begin{array}{l} 30 + 10 = 40 \times 20 = 800 \\ 20 + 15 = 35 \times 10 = \underline{350} \\ \qquad\qquad\qquad\quad \underline{1150} \times 10 = 11500 \end{array}$$

BY RULE II.

$$\begin{array}{l} 30 \times 20 = \ 600 \\ \underline{20} \times \overline{10} = \ 200 \\ 50 \times 30 = \underline{1500} \\ \qquad\quad\ \ \underline{2300} \times 5 = 11500 \end{array}$$

Then 11500 ÷ 277·274 (see page 31) = 41·4752 gallons.

When the sides of the solid are straight between the bases, half the sum of the two corresponding sides, or diameters, of the bases, will give the corresponding side or diameter of the middle section; and the product of the sums of the two respective corresponding sides will be equal to four times the area of the middle section; as shown in the foregoing example by Rule II.

If the ends be elliptical, the transverse diameter of the middle section will be equal to half the sum of the transverse diameters of the two ends, and the conjugate diameter equal to half the sum of the conjugate diameters of the two ends.

If one end be an ellipsis and the other a circle, the transverse diameter of the elliptical end must be added to the diameter of the circular end; and half the sum taken for the transverse diameter of the middle section. The conjugate diameter of the middle section must be found in a similar manner.

If the ends be irregular the contents may be found by the application of Rule II. to the rules for perpendicular ordinates, (page 108, &c.,) as follows:—

(2.) Required the area of a vessel whose sides are straight, and of the depth of 60 inches; and the dimensions of whose bases, taken according to the directions for nine equidistant perpendicular ordinates, are as follows:—

BOTTOM.—Transverse 134; 1st perpendicular 40·8, 2nd 62·7, 3rd 76·3, 4th 82·9, 5th (conjugate) 85·2, 6th 83, 7th 76·1, 8th 62·8, 9th 41. Sum of the segments, 14.

TOP.—Transverse 124; 1st perpendicular 19·4, 2nd 54·0, 3rd 69·0, 4th 76·4, 5th (conjugate) 78·0, 6th 76·3, 7th 68·8, 8th 53·7, 9th 19·6. Sum of the segments, 4.

Here the area of the top base, calculated according to the rules and examples in page 109, is 32·4398 gallons; and the area of the bottom base, calculated according to the same rule and examples, is 27·4565.

square, or the circular divisor if it be curved, the content will be obtained in terms of the employed divisor.

**Rule II.**—Find the areas of the two bases, and also the area of a section parallel to and equidistant from the bases; then to four times the middle area add the other two areas; and the sum, multiplied by one-sixth of the length, will give the solid content.

---

The sides being straight, (see page 133,) half the sum of the two corresponding diameters will be the corresponding diameters of the middle section. The dimensions found by this rule, and calculated in the same manner as the other two bases, shew the area of the middle section to be 29·8196 gallons. Then,

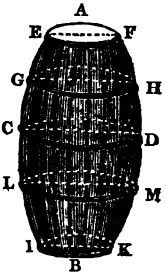
BY RULE II.

Middle section 29·8196 × 4 = 119·2784
Upper base .............. 32·4398
Lower base .............. 27·4565

179·1747
10 $\frac{1}{6}$ of the depth.

Content of the vessel 1791·747 gallons.

When the extreme thicknesses of a solid are not at the ends, it may sometimes be divided into portions which have their extreme thicknesses at the ends; that is, into two or more prismoids; in which case, the contents of their portions may be found separately and added together; the sum will be the content of the whole. Thus:



(3.) What is the content of a round solid of which the whole length, A B, is 370 inches, the greatest girt, C D, 77 inches; is 160 inches from the greater end, E F, of which the girt is 54, and the middle girt, G H, 67; also the girt at the less end, I K, is 36 inches, and the middle girt, L M, 59 inches?

Here 160 inches is the length of one portion of the solid, and 370 — 160 = 210 is the length of the other portion; hence,

BY RULE II.

77 × 77 = 5929
54 × 54 = 2916
4 × 67 × 67 = 17956

26801 × 160 ÷ 6 = 714693·3333

77 × 77 = 5929
36 × 36 = 1296
4 × 59 × 59 = 13924

21149 × 210 ÷ 6 = 740215

TO FIND THE CONTENT OF A WEDGE.*—To the length of the edge add twice the length of the base; multiply that sum by the height and by the breadth of the base, and one-sixth of that product will be the solidity.

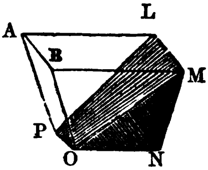
---

Then 714693·3333 + 740215 = 1454908·3333
Constant factor when circumference is given ·07958
Content 115781·60516 cubic inches.

Then 115781·60516 ÷ 1728 = 67 cubic feet 5⅝ cubic inches.
And 115781·60516 ÷ 277·274 = 417·57108 imperial gallons.

* EXAMPLES OF THE WEDGE.

(4.) Let L M N O P be a wedge, the length of the base, L P, being 35 inches, the breadth, L M, 15, the edge 40, and the perpendicular height from it 18 inches; what is the content?
Here (2 × 35 + 40) × 15 = 110 × 15 = 1650
One-sixth of altitude.............. 3

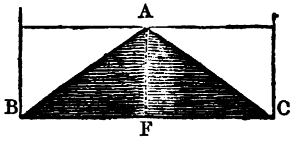


Content 4950 cubic inches = 17·85237 gallons (see p. 31.)

The perpendicular height of a wedge may be found by extracting the square-root of the difference between the square of the slant height and the square of half the breadth.

The slant height may be obtained by extracting the square-root of the sum of the square of the height and the square of half the breadth.

(5.) Suppose a quantity of malt be disposed in the form of a wedge; its height, A F, being 8 inches, the breadth of its base, B C, being 20 inches, its length 40 inches, and its edge 20 inches. What is its content?



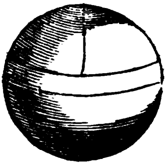
Here (20 + 2 × 40) × 8 × 20 × $\frac{1}{6}$ = 16000 ÷ 6 = 2666·666 inches = 1·20218 bushels.

If the length of the base be equal to that of the edge, the wedge is evidently equal to half a prism of the same base and altitude; and it will then only be necessary to multiply the length, breadth, and height together, and take half the product for the solidity of the wedge.

(6.) Suppose a malt store to be in the form of a wedge, its perpendicular height, A F, being 400 inches, the length of its base and edge being each 350 inches, and its breadth, B C, 300 inches; what is its content in bushels?

Here 400 × 350 × 300 ÷ 2 = 21000000 = 9467·1696 bushels.

### 4. *Of the Sphere and its Sections.*



A SPHERE,* or globe, is a round solid, every part of which is equally distant from a certain point within it called its *centre*. It is generated by the rotation of a circle or semicircle upon one of its diameters as an axis. One half of a sphere is called a *hemisphere*.

A *segment* of a sphere is any portion of it which is cut off by a plane; and the circle in which the plane cuts the sphere is called the *base* of the segment. A *zone* is a part intercepted between two parallel lines, and is, therefore, the difference between two segments. When the ends, or planes, are equally distant from the centre on both sides, the figure is called a *middle zone*.

A *sector* of a sphere has a right cone added to the segment.

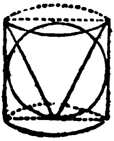
The *diameter* of a sphere is any right line passing through the centre and terminated both ways by the surface.

---

* THEOREMS RELATING TO THE SPHERE, &c.

1. The surface of a sphere is equal to the product of the circumference and diameter of the generating circle; that is, to four times the area of one its great circles.

2. The surfaces of spheres are as the squares of the radii, and their solid contents are as the cubes of their radii. Hence, if the diameter of a sphere be 1, its circumference and superficial content are equal, namely, 3·141592; and if the diameter be 6, the solidity and superficial content are equal, namely, 113·097312.



3. The solid content of a sphere is to that of a cylinder, (see page 114) of equal base and altitude, (the diameter of the base of the cylinder being equal to that of the sphere,) in the proportion of two to three; and to that of a cone of equal base and altitude, as two to one. These beautiful relations were discovered by Archimedes.

4. Every section of a sphere by a plane is a circle.

5. If one-half of the diameter of a spherical segment be squared, and the product divided by the altitude, the quotient will give the altitude of the other segment.

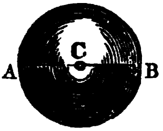
TO FIND THE CONTENT OF A SPHERE.* RULE I.—Find the area of a circle in the middle of the sphere; multiply it by two-thirds of the height; the product will be the content.

RULE II.—Multiply the cube of the diameter by ·5236 (the content of a sphere whose diameter is 1); the product will be the content.

---

* EXAMPLES OF A SPHERE.

(1.) What is the content of a sphere whose diameter, A B, is 12·5 inches?



BY RULE I.

Here the constant factor is ·7854
$AB^2 = 12{\cdot}5 \times 12{\cdot}5 =$ 156·25
Area of circle ...... 122·71875
$\frac{2}{3}$ of 12·5 .......... $8\frac{1}{3}$

BY RULE II.

$12{\cdot}5 \times 12{\cdot}5 \times 12{\cdot}5 = 1953{\cdot}125$
·5236
Content 1022·65625 inches.

Content 1022·65625 inches ÷ 277·274 = 3·68825 gallons.

SPHERICAL FACTORS, DIVISORS, &C.

Instead of multiplying by ·5236, a factor or divisor may be used, which will produce the answer, in gallons or bushels, at one operation. Such factors and divisors may be found and used as follows:—

As every sphere is equal to two-thirds of its circumscribing cylinder, (see theorem 3, page 136,) it is evident that two-thirds of the circular factors (see pages 57, 91,) will be the factors for a sphere; thus:

·0028326 × 2 ÷ 3 = ·0018884 Factor for gallons.
·000354 × 2 ÷ 3 = ·000236 Factor for bushels.

The divisors for a sphere are in the same ratio, but inversely, hence $\frac{3}{2}$ of the circular divisors (see pages 57, 91,) will be the divisors for a sphere, and may be found thus:

As 1 : 1·5 : : 353·036 : 529·554 Divisor for gallons.
As 1 : 1·5 : : 2824·289 : 4236·434 Divisor for bushels.

The gauge-points for a sphere are the square-roots of the spherical divisors. (See "Gauging," &c., *infra.*)

(2.) Let A B C be a globe, or sphere, whose diameter is 20 inches; what is its content in gallons?

BY A FACTOR.

Factor ·0018884
$20^2 =$ 400
$\cdot 75536 \times 20 = 15{\cdot}1072$ galls.

BY A DIVISOR.

$$\frac{20 \times 20 \times 20}{529{\cdot}554} = \frac{8000}{529{\cdot}554} = 15{\cdot}1072 \text{ galls.}$$

### TO FIND THE CONTENT OF THE SEGMENT OF A SPHERE.*

RULE I.—To three times the square of the radius, or half diameter, of the segment's base, add the square of its height or depth; multiply the sum by the height or depth, and the last product by ·5236, or by the proper factor for a sphere or globe; and the last product will be the content in terms of the factor employed.

RULE II.—To the square of the diameter of the seg-

---

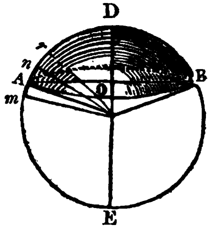
* EXAMPLE OF THE SEGMENT OF A SPHERE.

(3.) What is the content of the spherical segment A D B O; the diameter of the circular base, A B, being 36 inches, and the height, D O, 15 inches?

BY RULE I.

Here the radius of the base being $\frac{36}{2}$ = 18 inches, we have

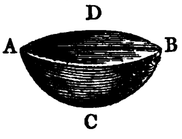
18 × 18 × 3 = 324 × 3 = 972
Add square of height 15 × 15 = 225
1197
Multiplied by the height 15
17955
Constant factor (see p. 137) ·5236
Content 9401·2380 cubic inches.



Or thus, (3 × $18^2$ + $15^2$) × 15 × ·0018884 (factor for spheres, see page 137) = (972 + 225) × 15 × ·018884 = 1197 × 15 × ·0018884 = 17955 × ·0018884 = 33·906 gallons. (See Gutteridge's "Gauger," page 65, showing the advantage of this mode of working over that recommended in Ballard's "Gauging," page 96.)

The semi-diameter of a segment as A o = o B is a mean proportional between E o × o D, and the square of A o = o B is always equal to the product of E o × o D.

(4.) What is the content of a copper in the form of the segment of a sphere, the diameter of its base, A B, being 40 inches, and the depth, D C, 18 inches?



BY RULE II.

Here $18 + \frac{20^2}{18} = 18 + \frac{400}{18} = 18 + 22·2222 = 40·2222$ = diameter of sphere of which A C B is a segment. (See page 94, example 11.)

Then $40^2 + 2 \times 40·2222 \times 18 = 1600 + 1448 = 3048$.

And 3048 × 18 × ·2618 = 14363·3952 cubic inches.

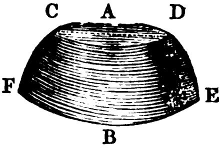
ment's base, add twice the product of the diameter of the sphere and the height of the segment; multiply the sum by the height of the segment, and the last product by ·2618 for the content of the segment required.

RULE III.—Multiply the difference between three times the diameter of the sphere and twice the height of the segment, by the square of the height; the last product multiplied by ·5236 will give the content.

TO FIND THE CONTENT OF A ZONE OR FRUSTUM OF A SPHERE.*—To half the sum of the squares of the top and bottom diameters add two-thirds of the square of the height; multiply this sum by the height; divide the product by a circular divisor, or multiply it by a circular factor; and the result will be the content in terms of the employed divisor or factor.

---

* EXAMPLES OF THE ZONE OF A SPHERE.



(5.) Required the content of a spherical zone or frustum, of which the height, A B, is 10 inches, and the diameters at its ends, C D and E F, are 50 and 60 inches respectively.

$60^2 + 50^2 = 6100 \div 2 = 3050$

$10 \times 10 \times \frac{2}{3} = 66{\cdot}66$

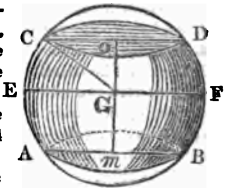
$3116{\cdot}66 \times 10 = 31166{\cdot}66 \times {\cdot}7854 = 24478{\cdot}3$ cubic in.

(6.) What is the content in gallons of the shoulder of a still in the form of the frustum of a sphere, the height being 30 inches, the top diameter 42, and the bottom diameter 36 inches?

$(42^2 + 36^2) \div 2 = 1530$

$30^2 \times \frac{2}{3} = 600$

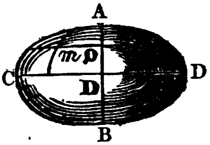
$2130 \times 30 = 63900 \div 353{\cdot}036$ (see page 31) $= 181$ galls.



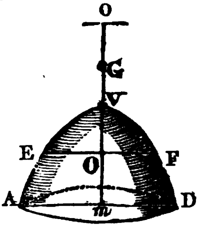
For the middle zone, it will only be necessary to subtract from the square of the axis, or greater diameter, $\frac{1}{3}$ of the square of the height, and multiply the remainder by the height and by ·7854; thus:

(7.) Required the content of the middle zone of a sphere, of which the axis is 44 inches, and the height of the zone 14 inches. $(44^2 - \frac{1}{3} \times 14^2) \times 14 \times {\cdot}7854 = 20569{\cdot}1024$ cubic inches.—*Ingram's Mathematics.*

### 5. *Of Spheroids, Conoids, and Spindles.**

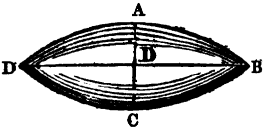


A *spheroid* is a solid which may be supposed to be generated by the revolution of an ellipsis about one of its axes; as A C B D. If it revolve about its greater axis, the solid generated is called a *prolate* or *oblong spheroid;* and if it revolve about the lesser axis, the solid is called an *oblate spheroid.*



A *conoid* is generated by the revolution of a curve about its axis; and it is called a *parabolic conoid*, or an *hyperbolic conoid*, according as the generating curve is a parabola or an hyperbola.

Any part of a conoid cut off from the vertex by a plane perpendicular to the axis of revolution is called a *segment;* and what it wants of the whole conoid is called a *frustum.*



If a circle, or any one of the conic sections, revolve round an ordinate to the axis thereof, the solid generated would be called a *spindle,*

---

* THEOREMS RELATING TO SPHEROIDS, &C.

1. A spheroid is equal to $\frac{2}{3}$ ............................ ⎫ of its circum-
2. A parabolic conoid is equal to $\frac{1}{2}$ ...................... ⎪ scribing cy-
3. An hyperbolic conoid is equal to $\frac{5}{12}$, or as 1 to 2·4 ⎬ linder, having the same base
4. A parabolic spindle is equal to $\frac{8}{15}$, or as 1 to ·875 ⎭ and altitude.

5. If a circle be described upon either axis of an ellipsis, and both revolve upon that axis, the spheroid generated by the ellipsis will be to the sphere described by the circle, as the circle described by the revolving axis of the ellipsis is to the circle described by the diameter of the circle; and so is any segment or frustum of the spheroid to the corresponding segment or frustum of the sphere.—*Ingram's Mathematics,* 154.

(as A B C D,) with the name of the generating curve prefixed. Thus,

| If the generating curve be a | | the solid generated is a | | |
|---|---|---|---|---|
| | circle, . . . | | circular . . | spindle. |
| | ellipsis, . . | | elliptic. . . | |
| | parabola,. . | | parabolic. . | |
| | hyperbola, | | hyperbolic | |

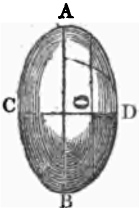
Any part of a spheroid, or spindle, cut off by a plane parallel to its axis is called a *segment*; and what it wants of half the spheroid, or spindle, is called a *frustum*.

TO FIND THE CONTENT OF A SPHEROID.—Multiply the square of the greatest diameter by the transverse diameter thereof, and that product by ·5236; the last product will be the content.*

TO FIND THE CONTENT OF THE SEGMENT OF A SPHEROID.†—Find the spherical segment which has the

---

* EXAMPLES OF A SPHEROID.



(1.) Required the solid content of an oblong spheroid, A D B C, the axes of the generating ellipsis being 54 and 36 inches respectively.

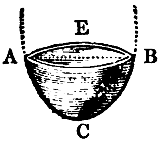
36 × 36 = 1296 × 54 = 69984 × ·5236 = 36643·6224 inches, or 132·1567 gallons. (See table page 53.)

Instead of the decimal ·5236, the divisors or factors for spheres (see page 137) may be used, if the answer be required in gallons or bushels.

(2.) Required the solid content of an oblate spheroid, the axes of the generating ellipsis being 42 and 30 inches respectively. Ans. 27708·912 inches.

The same result would be obtained by the following rule:—Find the area of the circle in the middle, and multiply it by the length; multiply the product by 2 and divide by 3; the quotient will be the solidity.

† EXAMPLE OF THE SEGMENT OF A SPHEROID.



(2.) The height, E C, of the segment of the oblong spheroid A B C E, of which the base is perpendicular to the fixed axis, is 16, and the axes are 48 and 38 inches; required the content.

3 × 48 = 144
2 × 16 = 32

112 × 16² = 28672 × ·5236 = 15012·6592.

As 48² : 15012·6592 : : 38² : 9408·97564, content.—*Ingram's Mathematics.*

same height and the same axis; then if the base be perpendicular to the fixed axis, the square of that axis is to the square of the other, as the spherical is to the spheroidal segment. But if the revolving axis be perpendicular to the base, that axis is to the fixed one, as the spherical is to the spheroidal segment.

TO FIND THE CONTENT OF THE MIDDLE ZONE OF A SPHEROID.*—To twice the area of the greatest base add the area of the least base, and multiply the sum by one-third of the length, or height; the product will be the solid content.

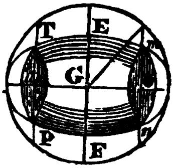
---

If the vessel be an exact half of a *prolate* spheroid, the content may be obtained by multiplying the square of the diameter by the perpendicular height, and dividing by 529·554 for gallons, and 4236·434 for bushels.

Any diameter parallel to the base of a prolate semi-spheroid may be found as follows:—To the altitude of the given vessel add the distance between its base and the required diameter, and from the altitude subtract the said distance; multiply the sum by the remainder, and extract the square-root of the product; then say as twice the altitude of the given vessel is to the diameter of its base, so is twice the above root to the diameter required.—*Nisbet and Little's Gauging.*

* EXAMPLE OF THE MIDDLE ZONE OF A SPHEROID.

Vessels in the form of a complete oblate spheroid are never met with in gauging, but casks are sometimes made in the form of the middle zone of a spheroid, and are then called, by gaugers, casks of the *first variety.*



(4.) Required the content of the middle zone, T P *m n*, of an oblong spheroid, the base being perpendicular to the fixed axis, the length, *o u*, 48, the greatest diameter, E F, 42, and the least, T P, 32 inches.

42 × 42 = 1764
1764
32 × 32 = 1024
4552 × 16 = 72832 × ·7854 = 57202·2528 inches = 206·3 gallons.

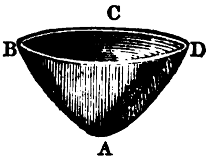
If the content be required in gallons or bushels, twice the square of the middle or greatest diameter added to the square of the end may be multiplied by the length of the frustum, and by one-third of the proper circular factor, that is, by ·0009442 for gallons, and for bushels ·00011804; the last product will be the content in terms of the employed factor.

TO FIND THE CONTENT OF A PARABOLIC CONOID.*—Multiply the square of the base by the height, and the product by half the circular factor, namely, by ·3927 for inches, ·001416 for gallons, or ·000178 for bushels; the last product will be the content in terms of the employed factor.

TO FIND THE CONTENT OF THE FRUSTUM OF A PARABOLIC CONOID.†—Multiply the sum of the squares of the two diameters by half the height, or depth, and by ·7854, or other circular factor; the product will be the content in terms of the employed factor.

---

* EXAMPLE OF A PARABOLIC CONOID.



(5.) Suppose A B D be a parabolic conoid, the diameter, B D, being 40 inches, and the height 30 inches, what is the solid content?

$40 \times 40 = 1600 \times 30 = 48000 \times \cdot3927 = 18849\cdot6$. Ans.

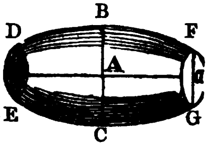
The same rule will also give the content of the segment of a paraboloid.

† EXAMPLES OF THE FRUSTUM OF A PARABOLIC CONOID.

(6.) If A E F D (fig. 2, page 140,) be the frustum of a parabolic conoid, the greatest diameter, A D, being 58 inches, the lesser diameter, E F, 30 inches, and the height, m O, 18 inches; what is the solid content?

$$58^2 = 3364$$
$$30^2 = 900$$
$$4264 \times 9 = 38376 \times \cdot7854 = 30140\cdot5104 \text{ inches. Ans.}$$

If the frustums of two equal paraboloids be joined together, at their greater ends they will form a figure which, by gaugers, is called a cask of the *third variety*.



(7.) Suppose a cask to be in the form of two equal frustums of a parabolic conoid, the length is 40 inches, the bung diameter, B C, 32, and the head diameter, D E or F G, 24 inches; what is the content in gallons?

$$(32^2 + 24^2) \times 20 \times \cdot0028326 = 90\cdot6432 \text{ gallons.}$$

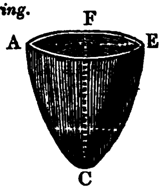
Any diameter parallel to the base of a paraboloid may be found as follows:—From the perpendicular altitude of the given vessel subtract the distance between the base and required diameter, and reserve the remainder; then say, as the perpendicular altitude of the given vessel is

TO FIND THE CONTENT OF AN HYPERBOLIC CONOID.* —To the square of the radius of the base add the square of the diameter in the middle between the top and bottom; multiply this sum by the height, and the product by ·5236; the last product will give the content.

TO FIND THE CONTENT OF A SPINDLE.†—To the square of the diameter in the middle of the spindle add the square of double the diameter at one-fourth of the length (that is, exactly between the middle and one of the ends); multiply the sum by the length, and the product again by ·1309, and it will give the solidity, very nearly.

---

to the square of the diameter of its base, so is the reserved remainder to the square of the required diameter; the square-root of this number will be the diameter sought.—*Nisbet and Little's Gauging.*



* EXAMPLE OF AN HYPERBOLIC CONOID.

(8.) What is the content of an hyperbolic conoid, the semi-diameter of the base being 52 inches, the diameter in the middle 68 inches, and the height 50 inches?

$(52^2 + 68^2) \times 50 = 366400 \times ·5236 = 191847$ inches.

If a vessel in the form of a frustum of an hyperbolic conoid should be met with, its content may be found as follows:—

Find a fourth proportional to the transverse, the conjugate, and the altitude, and subtract a third of its square from the sum of the squares of the radii of the bases; the remainder, multiplied by twice the altitude and by ·7854, will give the content.

† EXAMPLE OF A SPINDLE.

(9.) What is the solidity of a spindle, A C B D, whose length, A B, is 20 inches; the greatest diameter, C D, 6, and the diameter at $\frac{1}{4}$ of the length 4·74 inches?

$6^2 = 36$

$4·74 \times 2 = 9·48^2 = 89·8704$

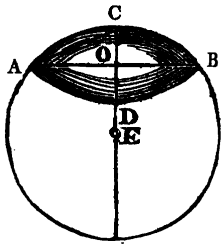
125·8704

20

2517·408

·1309

329·5287072 inches.



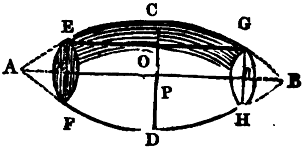
TO FIND THE CONTENT OF THE MIDDLE ZONE OF A CIRCULAR SPINDLE.—From the square of half the length of the spindle, subtract a third of the square of half the length of the zone, and multiply the remainder by half the length of the zone; also find the area of the space which generates the zone, and multiply it by the central distance, and subtract this from the former product; and twice the remainder, multiplied by 3·1416, will give the solid content.

---

Of a *parabolic* spindle the content may be obtained by multiplying the square of the middle diameter by the length, and dividing that product by $\frac{15}{8}$ of the circular divisor, namely, by 661·943 for gallons, and 5295·543 for bushels.

Of an *elliptical* spindle the content may be found as follows: Divide three times the area of the generating segment by the length of the spindle; and from the quotient subtract the greatest diameter, and multiply the remainder by four times the central distance, and subtract the product from the square of the greatest diameter; and the remainder multiplied by the length, and by ·5236 will give the content.

* EXAMPLE OF THE MIDDLE ZONE OF A CIRCULAR SPINDLE.



(10.) What is the content of the middle zone of a circular spindle, the length, *n o*, or G E, being 20 inches; the greatest diameter, C D, 16 inches; and the least diameter, E F, or G H, 12 inches?

Here $GO^2 \div CO = 100 \div 2 = 50$.

Then $50 + 2 = 52$ Diameter.

And $\frac{2}{52} = \frac{1}{26} = \cdot0384\frac{8}{13}$ Tabular versed sine.

| | |
|---|---|
| Circular segment (by Table, *infra*) is ...... | ·009941 |
| 52 × 52 = | 2704 |
| Area of segment G C E O G .............. | 26·880464 |
| Rectangle, G *n* = 20 × 6.................. | 120 |
| Generating area G C E *o n*................ | 146·880464 |
| Central distance = 26 − 8 = ............ | 18 |
| | 2643·848352 |

Again, $26^2 - 18^2 = 676 - 324 = 352 = AP^2$

$\frac{1}{3} nP^2 = \frac{1}{3} \times 10^2 = 100 \div 3 = 33\cdot33333$

318·66666

Then $318\cdot666666 \times 10 - 2643\cdot848352 = 542\cdot818314$, and $542\cdot818314 \times 2 \times 3\cdot1416 = 3410\cdot63063$ cubic inches; hence $3410\cdot63063 \div 277\cdot274 = 12\cdot3006$ gallons.

TO FIND THE CONTENT OF THE MIDDLE FRUSTUM OF A PARABOLIC SPINDLE.*—Add eight times the square of the middle diameter, three times the square of the end diameter, and four times the product of those diameters into one sum; multiply this sum by the length, and divide the product by fifteen times the circular divisors (namely, by 5295·54 for gallons, or by 42364·35 for bushels); the last product will be the content in terms of the employed factor.

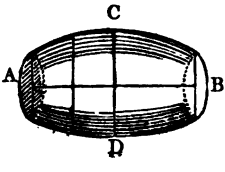
RULE II.—To twice the square of the middle diameter add the square of the diameter at the end; subtract therefrom four-tenths of the square of the difference between these diameters; the remainder multiplied by the length and by one-third of the circular factor, that is, by ·2618 for inches; ·0009442 for gallons; or ·00011804 for bushels; will give the content in terms of the employed factor.

---

[*] EXAMPLE OF THE MIDDLE FRUSTUM OF A PARABOLIC SPINDLE.

A cask in the form of the middle frustum of a parabolic spindle is called by gaugers a cask of the *second* variety, and is the most common of any of the varieties.

(11.) The length, A B, of a vessel in the form of the middle frustum of a parabolic spindle is 20, the greatest diameter, C D, 16, and least diameter, E F or G H, 12 inches; required the solidity.



BY RULE I.

$$\begin{aligned} \text{Here } 16^2 \times 8 &= 2048 \\ 12^2 \times 3 &= 432 \\ 16 \times 12 \times 4 &= 768 \end{aligned}$$

$$3248 \times 20 \div 5295{\cdot}54 = 12{\cdot}2669 \text{ gallons.}$$

(12.) The bung diameter, C D, of a cask is 32 inches, the head diameter, G H, 24 inches, and the length, A B, 40 inches; what is the content?

BY RULE II.

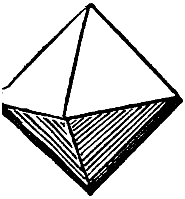
$$(2 \times 32^2 + 24^2 - {\cdot}4 \times 8^2) \times 40 = 103936 \times {\cdot}0009442 = 98{\cdot}1364 \text{ gallons.}$$

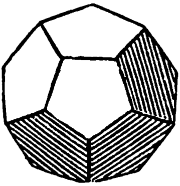
This is, in effect, the same as the rule for a prismoid, (Rule II. page 132) which is applicable to the middle frustum of any spindle.

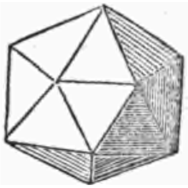
## 6. *Of the Five Regular Bodies.*

A **Regular Body** is a solid bounded by similar and egular planes and angular figures. Of these there can e only five; namely, the

| | | |
|---|---|---|
| Tetraedron,. | contained by | four equilateral triangles. (p. 126) |
| Hexaedron,. | | six squares. (See page 114.) |
| Octaedron,.. | | eight triangles. (See fig. 1.) |
| Dodecaedron, | | twelve pentagons. (See fig. 2.) |
| Icosaedron,. | | twenty triangles. (See fig. 3.) |







To find the content.*—Multiply the proper tabular-olidity (taken from the following table) by the cube of he linear edge; the product will be the solid content.

| No. of faces. | Names. | Superficies. | Solidities. |
|---|---|---|---|
| 4 | Tetraedron. | 1·73205 | 0·11785 |
| 6 | Hexaedron. | 6·00000 | 1·00000 |
| 8 | Octaedron. | 3·46410 | 0·47140 |
| 12 | Dodecaedon. | 20·64578 | 7·66312 |
| 20 | Icosaedron. | 8·66025 | 2·18169 |

---

* To find the superficies of any regular body, multiply the tabular area 'surfaces, taken from the above table, by the square of the linear edge the solids, and the product will be the superficies.

## 7. *Mathematical Tables*

### No. 1.

### TABLE *of the* AREAS *of* SEMI-SQUARES *in* IMPERIAL GALLONS.

| Sides in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ·00002 | ·00007 | ·00016 | ·00029 | ·00045 | ·00065 | ·00088 | ·00115 | ·00146 |
| 1 | ·0018 | ·0022 | ·0026 | ·0030 | ·0035 | ·0041 | ·0046 | ·0052 | ·0858 | ·0065 |
| 2 | ·0072 | ·0080 | ·0087 | ·0095 | ·0104 | ·0113 | ·0122 | ·0131 | ·0141 | ·0152 |
| 3 | ·0162 | ·0173 | ·0185 | ·0196 | ·0208 | ·0221 | ·0234 | ·0247 | ·0260 | ·0274 |
| 4 | ·0289 | ·0303 | ·0318 | ·0333 | ·0349 | ·0365 | ·0382 | ·0398 | ·0415 | ·0433 |
| 5 | ·0451 | ·0469 | ·0488 | ·0507 | ·0526 | ·0545 | ·0566 | ·0586 | ·0607 | ·0628 |
| 6 | ·0649 | ·0671 | ·0693 | ·0716 | ·0739 | ·0762 | ·0786 | ·0809 | ·0834 | ·0859 |
| 7 | ·0884 | ·0909 | ·0935 | ·0961 | ·0987 | ·1014 | ·1042 | ·1069 | ·1097 | ·1125 |
| 8 | ·1154 | ·1183 | ·1213 | ·1242 | ·1272 | ·1303 | ·1334 | ·1365 | ·1396 | ·1428 |
| 9 | ·1461 | ·1493 | ·1526 | ·1560 | ·1593 | ·1627 | ·1662 | ·1697 | ·1732 | ·1767 |
| 10 | ·1803 | ·1840 | ·1876 | ·1913 | ·1950 | ·1988 | ·2026 | ·2065 | ·2103 | ·2142 |
| 11 | ·2182 | ·2222 | ·2262 | ·2303 | ·2344 | ·2385 | ·2426 | ·2468 | ·2511 | ·2554 |
| 12 | ·2597 | ·2640 | ·2684 | ·2728 | ·2773 | ·2818 | ·2863 | ·2908 | ·2954 | ·3001 |
| 13 | ·3048 | ·3095 | ·3142 | ·3190 | ·3238 | ·3286 | ·3335 | ·3385 | ·3434 | ·3484 |
| 14 | ·3534 | ·3585 | ·3636 | ·3688 | ·3739 | ·3791 | ·3844 | ·3897 | ·3950 | ·4003 |
| 15 | ·4057 | ·4112 | ·4166 | ·4221 | ·4277 | ·4332 | ·4388 | ·4445 | ·4502 | ·4559 |
| 16 | ·4616 | ·4674 | ·4733 | ·4791 | ·4850 | ·4909 | ·4969 | ·5029 | ·5090 | ·5150 |
| 17 | ·5211 | ·5273 | ·5335 | ·5397 | ·5460 | ·5523 | ·5586 | ·5649 | ·5713 | ·5778 |
| 18 | ·5843 | ·5908 | ·5973 | ·6039 | ·6105 | ·6172 | ·6239 | ·6306 | ·6373 | ·6441 |
| 19 | ·6510 | ·6579 | ·6648 | ·6717 | ·6787 | ·6857 | ·6927 | ·6998 | ·7070 | ·7141 |
| 20 | ·7213 | ·7285 | ·7358 | ·7431 | ·7504 | ·7578 | ·7652 | ·7727 | ·7802 | ·7877 |
| 21 | ·7952 | ·8028 | ·8105 | ·8181 | ·8258 | ·8336 | ·8413 | ·8491 | ·8570 | ·8649 |
| 22 | ·8728 | ·8807 | ·8887 | ·8967 | ·9048 | ·9129 | ·9210 | ·9292 | ·9374 | ·9457 |
| 23 | ·9539 | ·9622 | ·9706 | ·9790 | ·9874 | ·9959 | 1·0043 | 1·0129 | 1·0214 | 1·0300 |
| 24 | 1·0387 | 1·0474 | 1·0561 | 1·0648 | 1·0736 | 1·0824 | 1·0913 | 1·1002 | 1·1091 | 1·1180 |
| 25 | 1·1270 | 1·1361 | 1·1451 | 1·1543 | 1·1634 | 1·1726 | 1·1818 | 1·1910 | 1·2003 | 1·2097 |
| 26 | 1·2190 | 1·2284 | 1·2378 | 1·2473 | 1·2568 | 1·2663 | 1·2759 | 1·2855 | 1·2952 | 1·3049 |
| 27 | 1·3146 | 1·3243 | 1·3341 | 1·3440 | 1·3538 | 1·3637 | 1·3737 | 1·3836 | 1·3936 | 1·4037 |
| 28 | 1·4138 | 1·4239 | 1·4340 | 1·4442 | 1·4544 | 1·4647 | 1·4750 | 1·4853 | 1·4957 | 1·5061 |
| 29 | 1·5166 | 1·5270 | 1·5375 | 1·5481 | 1·5587 | 1·5693 | 1·5800 | 1·5906 | 1·6014 | 1·6121 |
| 30 | 1·6229 | 1·6338 | 1·6447 | 1·6556 | 1·6665 | 1·6775 | 1·6885 | 1·6996 | 1·7107 | 1·7218 |
| 31 | 1·7329 | 1·7441 | 1·7554 | 1·7666 | 1·7780 | 1·7893 | 1·8007 | 1·8121 | 1·8235 | 1·8350 |
| 32 | 1·8465 | 1·8581 | 1·8697 | 1·8813 | 1·8930 | 1·9047 | 1·9164 | 1·9282 | 1·9400 | 1·9519 |
| 33 | 1·9638 | 1·9757 | 1·9876 | 1·9995 | 2·0117 | 2·0237 | 2·0358 | 2·0480 | 2·0601 | 2·0723 |
| 34 | 2·0846 | 2·0969 | 2·1092 | 2·1215 | 2·1339 | 2·1463 | 2·1588 | 2·1713 | 2·1838 | 2·1964 |
| 35 | 2·2090 | 2·2216 | 2·2343 | 2·2470 | 2·2598 | 2·2726 | 2·2854 | 2·2983 | 2·3111 | 2·3241 |
| 36 | 2·3370 | 2·3500 | 2·3631 | 2·3762 | 2·3893 | 2·4024 | 2·4156 | 2·4288 | 2·4421 | 2·4554 |
| 37 | 2·4687 | 2·4820 | 2·4954 | 2·5089 | 2·5223 | 2·5358 | 2·5494 | 2·5630 | 2·5766 | 2·5902 |
| 38 | 2·6039 | 2·6176 | 2·6314 | 2·6452 | 2·6590 | 2·6729 | 2·6868 | 2·7007 | 2·7147 | 2·7287 |
| 39 | 2·7428 | 2 7569 | 2·7710 | 2·7851 | 2·7993 | 2·8136 | 2·8278 | 2·8421 | 2·8565 | 2·8708 |
| 40 | 2·8852 | 2·8997 | 2·9142 | 2·9287 | 2·9432 | 2·9578 | 2·9724 | 2·9871 | 3·0018 | 3·0165 |
| 41 | 3·0313 | 3·0461 | 3·0609 | 3·0758 | 3·0907 | 3·1057 | 3·1207 | 3·1357 | 3·1507 | 3·1658 |
| 42 | 3·1810 | 3·1961 | 3·2113 | 3·2266 | 3·2418 | 3·2572 | 3·2725 | 3·2879 | 3·3033 | 3·3188 |
| 43 | 3·3342 | 3·3498 | 3·3653 | 3·3809 | 3·3966 | 3·4122 | 3·4279 | 3·4437 | 3·4595 | 3·4753 |
| 44 | 3·4911 | 3·5070 | 3·5229 | 3·5389 | 3·5549 | 3·5709 | 3·5870 | 3·6031 | 3·6192 | 3·6354 |
| 45 | 3·6516 | 3·6679 | 3·6842 | 3·7005 | 3·7168 | 3·7332 | 3·7496 | 3·7661 | 3·7826 | 3·7991 |
| 46 | 3·8157 | 3·8323 | 3·8490 | 3·8657 | 3·8824 | 3·8991 | 3·9159 | 3·9327 | 3·9496 | 3·9665 |
| 47 | 3·9834 | 4·0004 | 4·0174 | 4·0344 | 4·0515 | 4·0686 | 4·0858 | 4·1030 | 4·1202 | 4·1374 |
| 48 | 4·1547 | 4·1721 | 4·1894 | 4·2068 | 4·2243 | 4·2417 | 4·2593 | 4·2768 | 4·2944 | 4·3120 |
| 49 | 4·3297 | 4·3473 | 4·3651 | 4·3828 | 4·4006 | 4·4185 | 4·4363 | 4·4542 | 4·4722 | 4·4902 |
| 50 | 4·5082 | 4·5262 | 4·5443 | 4·5624 | 4·5806 | 4·5988 | 4·6170 | 4·6353 | 4·6536 | 4·6719 |

## TABLE *of the* AREAS *of* SEMI-SQUARES *in* IMPERIAL GALLONS.

*(Continued.)*

| Sides in inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 4·6903 | 4·7087 | 4·7272 | 4·7456 | 4·7642 | 4·7827 | 4·8013 | 4·8199 | 4·8386 | 4·8573 |
| 52 | 4·8760 | 4·8948 | 4·9136 | 4·9325 | 4·9513 | 4·9703 | 4·9892 | 5·0082 | 5·0272 | 5·0463 |
| 53 | 5·0654 | 5·0845 | 5·1037 | 5·1229 | 5·1421 | 5·1614 | 5·1807 | 5·2001 | 5·2195 | 5·2389 |
| 54 | 5·2583 | 5·2778 | 5·2974 | 5·3169 | 5·3365 | 5·3562 | 5·3758 | 5·3955 | 5·4153 | 5·4351 |
| 55 | 5·4549 | 5·4747 | 5·4946 | 5·5146 | 5·5345 | 5·5545 | 5·5746 | 5·5946 | 5·6147 | 5·6349 |
| 56 | 5·6551 | 5·6753 | 5·6955 | 5·7158 | 5·7361 | 5·7565 | 5·7769 | 5·7973 | 5·8178 | 5·8383 |
| 57 | 5·8588 | 5·8794 | 5·9000 | 5·9207 | 5·9413 | 5·9621 | 5·9828 | 6·0036 | 6·0244 | 6·0453 |
| 58 | 6·0662 | 6·0871 | 6·1081 | 6·1291 | 6·1502 | 6·1712 | 6·1924 | 6·2135 | 6·2347 | 6·2559 |
| 59 | 6·2772 | 6·2985 | 6·3198 | 6·3412 | 6·3626 | 6·3840 | 6·4055 | 6·4270 | 6·4486 | 6·4702 |
| 60 | 6·4918 | 6·5134 | 6·5351 | 6·5569 | 6·5786 | 6·6004 | 6·6223 | 6·6441 | 6·6660 | 6·6880 |
| 61 | 6·7100 | 6·7320 | 6·7540 | 6·7761 | 6·7983 | 6·8204 | 6·8426 | 6·8649 | 6·8871 | 6·9094 |
| 62 | 6·9318 | 6·9542 | 6·9766 | 6·9990 | 7·0215 | 7·0440 | 7·0666 | 7·0892 | 7·1118 | 7·1345 |
| 63 | 7·1572 | 7·1799 | 7·2027 | 7·2255 | 7·2484 | 7·2712 | 7·2942 | 7·3171 | 7·3401 | 7·3631 |
| 64 | 7·3862 | 7·4093 | 7·4324 | 7·4556 | 7·4788 | 7·5021 | 7·5253 | 7·5487 | 6·5720 | 7·5954 |
| 65 | 7·6188 | 7·6423 | 7·6658 | 7·6893 | 7·7129 | 7·7365 | 7·7601 | 7·7838 | 7·8075 | 7·8313 |
| 66 | 7·8550 | 7·8789 | 7·9027 | 7·9266 | 7·9505 | 7·9745 | 7·9985 | 8·0226 | 8·0466 | 8·0707 |
| 67 | 8·0949 | 8·1191 | 8·1433 | 8·1675 | 8·1918 | 9·2162 | 8·2405 | 8·2649 | 8·2893 | 8·3 .38 |
| 68 | 8·3383 | 8·3629 | 8·3874 | 8·4121 | 8·4367 | 8·4614 | 8·4861 | 8·5109 | 8·5357 | 8·5605 |
| 69 | 8·5854 | 8·6103 | 8·6352 | 8·6602 | 8·6852 | 8·7102 | 8·7353 | 8·7604 | 8·7856 | 8·8108 |
| 70 | 8·8360 | 1·8613 | 8·8866 | 8·9119 | 8·9373 | 8·9627 | 8·9881 | 9·0136 | 9·0391 | 9·0647 |
| 71 | 9·0903 | 9·1159 | 9·1416 | 9·1673 | 9·1930 | 9·2188 | 9·2446 | 9·2704 | 9·2963 | 9·3222 |
| 72 | 9·3482 | 9·3741 | 9·4002 | 9·4262 | 9·4523 | 9·4784 | 9·5046 | 9·5308 | 9·5570 | 9·5833 |
| 73 | 9·6096 | 9·6360 | 9·6624 | 9·6888 | 9·7152 | 9·7417 | 9·7682 | 9·7948 | 9·8214 | 9·8480 |
| 74 | 9·8747 | 9·9014 | 9·9282 | 9·9549 | 9·9818 | 10·0086 | 10·0355 | 10·0624 | 10·0894 | 10·1164 |
| 75 | 10·1434 | 10·1705 | 10·1976 | 10·2247 | 10·2519 | 10·2791 | 10·3063 | 10·3336 | 10·3609 | 10·3883 |
| 76 | 10·4157 | 10·4431 | 10·4706 | 10·4981 | 10·5256 | 10·5532 | 10·5808 | 10·6084 | 10·6361 | 10·6638 |
| 77 | 10·6916 | 10·7194 | 10·7472 | 10·7751 | 10·8030 | 10·8309 | 10·8589 | 10·8869 | 10·9149 | 10·9430 |
| 78 | 10·9711 | 10·9992 | 11·0274 | 11·0557 | 11·0839 | 11·1122 | 11·1405 | 11·1689 | 11·1973 | 11·2257 |
| 79 | 11·2542 | 11·2827 | 11·3113 | 11·3398 | 11·3685 | 11·3971 | 11·4258 | 11·4545 | 11·4833 | 11·5121 |
| 80 | 11·5409 | 11·5698 | 11·5987 | 11·6276 | 11·6566 | 11·6856 | 11·7147 | 11·7438 | 11·7729 | 11·8021 |
| 81 | 11·8313 | 11·8605 | 11·8898 | 11·9191 | 11·9484 | 11·9778 | 12·0072 | 12·0366 | 12·0661 | 12·0956 |
| 82 | 12·1252 | 12·1548 | 12·1844 | 12·2141 | 12·2438 | 12·2735 | 12·3033 | 12·3331 | 12·3629 | 12·3928 |
| 83 | 12·4227 | 12·4527 | 12·4827 | 12·5127 | 12·5428 | 12·5729 | 12·6030 | 12·6332 | 12·6634 | 12·6936 |
| 84 | 12·7239 | 12·7542 | 12·7845 | 12·8149 | 12·8453 | 12·8758 | 12·9063 | 12·9368 | 12·9674 | 12·9980 |
| 85 | 13·0286 | 13·0593 | 13·0900 | 13·1208 | 13·1515 | 13·1824 | 13·2132 | 13·2441 | 13·2750 | 13·3060 |
| 86 | 13·3370 | 13·3680 | 13·3991 | 13·4302 | 13·4613 | 13·4925 | 13·5237 | 13·5550 | 13·5863 | 13·6176 |
| 87 | 13·6490 | 13·6803 | 13·7118 | 13·7432 | 13·7747 | 13·8063 | 13·8379 | 13·8695 | 13·9011 | 13·9328 |
| 88 | 13·9645 | 13·9963 | 14·0281 | 14·0599 | 14·0918 | 14·1237 | 14·1556 | 14·1876 | 14·2196 | 14·2516 |
| 89 | 14·2837 | 14·3158 | 14·3480 | 14·3802 | 14·4124 | 14·4446 | 14·4769 | 14·5093 | 14·5416 | 14·5740 |
| 90 | 14·6065 | 14·6390 | 14·6715 | 14·7040 | 14·7366 | 14·7692 | 14·8019 | 14·8346 | 14·8673 | 14·9001 |
| 91 | 14·9329 | 14·9657 | 14·9986 | 15·0315 | 15·0644 | 15·0974 | 15·1304 | 15·1635 | 15·1966 | 15·2297 |
| 92 | 15·2629 | 15·2961 | 15·3293 | 15·3626 | 15·3959 | 15·4292 | 15·4626 | 15·4960 | 15·5295 | 15·5630 |
| 93 | 15·5965 | 15·6300 | 15·6636 | 15·6973 | 15·7309 | 15·7646 | 15·7984 | 15·8322 | 15·8660 | 15·8998 |
| 94 | 15·9337 | 15·9676 | 16·0016 | 16·0356 | 16·0696 | 16·1037 | 16·1378 | 16·1719 | 16·2061 | 16·2403 |
| 95 | 16·2745 | 16·3088 | 16·3431 | 16·3775 | 16·4119 | 16·4463 | 16·4807 | 16·5152 | 16·5498 | 16·5843 |
| 96 | 16·6189 | 16·6536 | 16·6883 | 16·7230 | 16·7577 | 16·7925 | 16·8273 | 16·8622 | 16·8971 | 16·9320 |
| 97 | 16·9670 | 17·0020 | 17·0370 | 17·0721 | 17·1072 | 17·1423 | 17·1775 | 17·2127 | 17·2480 | 17·2833 |
| 98 | 17·3186 | 17·3540 | 17·3894 | 17·4248 | 17·4603 | 17·4958 | 17·5313 | 17·5669 | 17·6025 | 17·6382 |
| 99 | 17·6739 | 17·7096 | 17·7453 | 17·7811 | 17·8170 | 17·8528 | 17·8887 | 17·9247 | 17·9606 | 17·9967 |
| 100 | 18·0327 | 18·0688 | 18·1049 | 18·1411 | 18·1773 | 18·2135 | 18·2497 | 18·2860 | 18·3224 | 18·3588 |

## TABLE *of the* AREAS *of* SEMI-SQUARES *in* IMPERIAL GALLONS.

*(Continued.)*

| Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 18·3952 | 151 | 41·1164 | 201 | 72·8539 | 251 | 113·6078 | 301 | 163·3781 | 351 | 222·1647 |
| 102 | 18·7612 | 152 | 41·6628 | 202 | 73·5806 | 252 | 114·5149 | 302 | 164·4655 | 352 | 223·4324 |
| 103 | 19·1309 | 153 | 42·2128 | 203 | 74·3110 | 253 | 115·4255 | 303 | 165·5565 | 353 | 224·7037 |
| 104 | 19·5042 | 154 | 42·7664 | 204 | 75·0449 | 254 | 116·3398 | 304 | 166·6510 | 354 | 225·9786 |
| 105 | 19·8811 | 155 | 43·3236 | 205 | 75·7824 | 255 | 117·2577 | 305 | 167·7492 | 355 | 227·2572 |
| 106 | 20·2615 | 156 | 43·8844 | 206 | 76·5236 | 256 | 118·1791 | 306 | 168·8510 | 356 | 228·5393 |
| 107 | 20·6456 | 157 | 44·4488 | 207 | 77·2683 | 257 | 119·1042 | 307 | 169·9564 | 357 | 229·8250 |
| 108 | 21·0333 | 158 | 45·0168 | 208 | 78·0167 | 258 | 120·0329 | 308 | 171·0654 | 358 | 231·1143 |
| 109 | 21·4247 | 159 | 45·5885 | 209 | 78·7687 | 259 | 120·9652 | 309 | 172·1781 | 359 | 232·4073 |
| 110 | 21·8196 | 160 | 46·1637 | 210 | 79·5242 | 260 | 121·9011 | 310 | 173·2943 | 360 | 233·7038 |
| 111 | 22·2181 | 161 | 46·7426 | 211 | 80·2834 | 261 | 122·8406 | 311 | 174·4141 | 361 | 235·0040 |
| 112 | 22·6202 | 162 | 47·3250 | 212 | 81·0462 | 262 | 123·7837 | 312 | 175·5376 | 362 | 236·3078 |
| 113 | 23·0260 | 163 | 47·9111 | 213 | 81·8126 | 263 | 124·7304 | 313 | 176·6646 | 363 | 237·6151 |
| 114 | 23·4353 | 164 | 48·5008 | 214 | 82·5826 | 264 | 125·6807 | 314 | 177·7952 | 364 | 238·9261 |
| 115 | 23·8483 | 165 | 49·0940 | 215 | 83·3562 | 265 | 126·6347 | 315 | 178·9295 | 365 | 240·2407 |
| 116 | 24·2648 | 166 | 49·6905 | 216 | 84·1334 | 266 | 127·5922 | 316 | 180·0674 | 366 | 241·5589 |
| 117 | 24·6850 | 167 | 50·2914 | 217 | 84·9142 | 267 | 128·5533 | 317 | 181·2088 | 367 | 242·8807 |
| 118 | 25·1087 | 168 | 50·8955 | 218 | 85·6986 | 268 | 129·5181 | 318 | 182·3539 | 368 | 244·2061 |
| 119 | 25·5361 | 169 | 51·5032 | 219 | 86·4867 | 269 | 130·4864 | 319 | 183·5026 | 369 | 245·5351 |
| 120 | 25·9671 | 170 | 52·1145 | 220 | 87·2783 | 270 | 131·4584 | 320 | 184·6549 | 370 | 246·8677 |
| 121 | 26·4017 | 171 | 52·7294 | 221 | 88·0735 | 271 | 132·4346 | 321 | 185·8108 | 371 | 248·2039 |
| 122 | 26·8399 | 172 | 53·3480 | 222 | 88·8724 | 272 | 133·4132 | 322 | 186·9703 | 372 | 249·5438 |
| 123 | 27·2817 | 173 | 53·9701 | 223 | 89·6748 | 273 | 134·3959 | 323 | 188·1334 | 373 | 250·8872 |
| 124 | 27·7271 | 174 | 54·5958 | 224 | 90·4809 | 274 | 135·3823 | 324 | 189·3001 | 374 | 252·2343 |
| 125 | 28·1761 | 175 | 55·2252 | 225 | 91·2906 | 275 | 136·3723 | 325 | 190·4704 | 375 | 253·5849 |
| 126 | 28·6287 | 176 | 55·8581 | 226 | 92·1038 | 276 | 137·3659 | 326 | 191·6444 | 376 | 254·9392 |
| 127 | 29·0849 | 177 | 56·4947 | 227 | 92·9207 | 277 | 138·3631 | 327 | 192·8219 | 377 | 256·2970 |
| 128 | 29·5448 | 178 | 57·1348 | 228 | 93·7412 | 278 | 139·3640 | 328 | 194·0030 | 378 | 257·6585 |
| 129 | 30·0082 | 179 | 57·7786 | 229 | 94·5653 | 279 | 140·3684 | 329 | 195·1878 | 379 | 259·0236 |
| 130 | 30·4753 | 180 | 58·4260 | 230 | 95·3930 | 280 | 141·3764 | 330 | 196·3761 | 380 | 260·3922 |
| 131 | 30·9459 | 181 | 59·0769 | 231 | 96·2243 | 281 | 142·3880 | 331 | 197·5681 | 381 | 261·7645 |
| 132 | 31·4202 | 182 | 59·7315 | 232 | 97·0592 | 282 | 143·4033 | 332 | 198·7637 | 382 | 263·1404 |
| 133 | 31·8981 | 183 | 60·3897 | 233 | 97·8977 | 283 | 144·4221 | 333 | 199·9629 | 383 | 264·5199 |
| 134 | 32·3795 | 184 | 61·0515 | 234 | 98·7399 | 284 | 145·4446 | 334 | 201·1656 | 384 | 265·9030 |
| 135 | 32·8646 | 185 | 61·7169 | 235 | 99·5856 | 285 | 146·4706 | 335 | 202·3720 | 385 | 267·2898 |
| 136 | 33·3533 | 186 | 62·3859 | 236 | 100·4349 | 286 | 147·5003 | 336 | 203·5820 | 386 | 268·6801 |
| 137 | 33·8456 | 187 | 63·0586 | 237 | 101·2879 | 287 | 148·5336 | 337 | 204·7956 | 387 | 270·0740 |
| 138 | 34·3415 | 188 | 63·7348 | 238 | 102·1444 | 288 | 149·5705 | 338 | 206·0128 | 388 | 271·4715 |
| 139 | 34·8410 | 189 | 64·4146 | 239 | 103·0046 | 289 | 150·6109 | 339 | 207·2336 | 389 | 272·8727 |
| 140 | 35·3441 | 190 | 65·0981 | 240 | 103·8684 | 290 | 151·6550 | 340 | 208·4581 | 390 | 274·2774 |
| 141 | 35·8508 | 191 | 65·7851 | 241 | 104·7257 | 291 | 152·7027 | 341 | 209·6861 | 391 | 275·6858 |
| 142 | 36·3611 | 192 | 66·4758 | 242 | 105·6057 | 292 | 153·7540 | 342 | 210·9177 | 392 | 277·0977 |
| 143 | 36·8751 | 193 | 67·1700 | 243 | 106·4813 | 293 | 154·8090 | 343 | 212·1530 | 393 | 278·5133 |
| 144 | 37·3926 | 194 | 67·8679 | 244 | 107·3595 | 294 | 155·8675 | 344 | 213·3918 | 394 | 279·9325 |
| 145 | 37·9138 | 195 | 68·5694 | 245 | 108·2413 | 295 | 156·9296 | 345 | 214·6343 | 395 | 281·3553 |
| 146 | 38·4385 | 196 | 69·2744 | 246 | 109·1267 | 296 | 157·9953 | 346 | 215·8803 | 396 | 282·7817 |
| 147 | 38·9669 | 197 | 69·9831 | 247 | 110·0157 | 297 | 159·0647 | 347 | 217·1300 | 397 | 284·2116 |
| 148 | 39·4988 | 198 | 70·6954 | 248 | 110·9083 | 298 | 160·1376 | 348 | 218·3833 | 398 | 285·6452 |
| 149 | 40·0344 | 199 | 71·4113 | 249 | 111·8046 | 299 | 161·2142 | 349 | 219·6401 | 399 | 287·0825 |
| 150 | 40·5736 | 200 | 72·1308 | 250 | 112·7044 | 300 | 162·2943 | 350 | 220·9006 | 400 | 288·5233 |

## TABLE *of the* AREAS *of* SEMI-SQUARES *in* IMPERIAL GALLONS.

*(Continued.)*

| Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 401 | 289·9677 | 451 | 366·7870 | 501 | 452·6227 | 551 | 547·4747 | 601 | 651·3431 | 651 | 764·2278 |
| 402 | 291·4157 | 452 | 368·4154 | 502 | 454·4314 | 552 | 549·4637 | 602 | 653·5124 | 652 | 766·5775 |
| 403 | 292·8673 | 453 | 370·0473 | 503 | 456·2436 | 553 | 551·4563 | 603 | 655·6854 | 653 | 768·9307 |
| 404 | 294·3226 | 454 | 371·6829 | 504 | 458·0595 | 554 | 553·4525 | 604 | 657·8619 | 654 | 771·2876 |
| 405 | 295·7814 | 455 | 373·3221 | 505 | 459·8790 | 555 | 555·4524 | 605 | 660·0421 | 655 | 773·6481 |
| 406 | 297·2439 | 456 | 374·9648 | 506 | 461·7021 | 556 | 557·4558 | 606 | 662·2258 | 656 | 776·0122 |
| 407 | 298·7099 | 457 | 376·6112 | 507 | 463·5289 | 557 | 559·4628 | 607 | 664·4132 | 657 | 778·3799 |
| 408 | 300·1796 | 458 | 378·2612 | 508 | 465·3592 | 558 | 561·4735 | 608 | 666·6042 | 658 | 780·7512 |
| 409 | 301·6529 | 459 | 379·9148 | 509 | 467·1931 | 559 | 563·4877 | 609 | 668·7987 | 659 | 783·1261 |
| 410 | 303·1298 | 460 | 381·5720 | 510 | 469·0306 | 560 | 565·5056 | 610 | 670·9969 | 660 | 785·5046 |
| 411 | 304·6102 | 461 | 383·2328 | 511 | 470·8718 | 561 | 567·5271 | 611 | 673·1987 | 661 | 787·8867 |
| 412 | 306·0943 | 462 | 384·8972 | 512 | 472·7165 | 562 | 569·5521 | 612 | 675·4041 | 662 | 790·2724 |
| 413 | 307·5820 | 463 | 386·5653 | 513 | 474·5649 | 563 | 571·5808 | 613 | 677·6131 | 663 | 792·6618 |
| 414 | 309·0733 | 464 | 388·2369 | 514 | 476·4168 | 564 | 573·6131 | 614 | 679·8257 | 664 | 795·0547 |
| 415 | 310·5682 | 465 | 389·9121 | 515 | 478·2724 | 565 | 575·6490 | 615 | 682·0420 | 665 | 797·4513 |
| 416 | 312·0668 | 466 | 391·5910 | 516 | 480·1316 | 566 | 577·6885 | 616 | 684·2618 | 666 | 799·8514 |
| 417 | 313·5689 | 467 | 393·2734 | 517 | 481·9943 | 567 | 579·7316 | 617 | 686·4852 | 667 | 802·2552 |
| 418 | 315·0746 | 468 | 394·9595 | 518 | 483·8607 | 568 | 581·7783 | 618 | 688·7122 | 668 | 804·6625 |
| 419 | 316·5840 | 469 | 396·6492 | 519 | 485·7307 | 569 | 583·8286 | 619 | 690·9429 | 669 | 807·0735 |
| 420 | 318·0969 | 470 | 398·3424 | 520 | 487·6043 | 570 | 585·8826 | 620 | 693·1771 | 670 | 809·4881 |
| 421 | 319·6135 | 471 | 400·0393 | 521 | 489·4815 | 571 | 587·9401 | 621 | 695·4150 | 671 | 811·9063 |
| 422 | 321·1336 | 472 | 401·7398 | 522 | 491·3623 | 572 | 590·0012 | 622 | 697·6565 | 672 | 814·3281 |
| 423 | 322·6574 | 473 | 403·4439 | 523 | 493·2468 | 573 | 592·0660 | 623 | 699·9015 | 673 | 816·7535 |
| 424 | 324·1847 | 474 | 405·1516 | 524 | 495·1348 | 574 | 594·1343 | 624 | 702·1502 | 674 | 819·1825 |
| 425 | 325·7157 | 475 | 406·8629 | 525 | 497·0264 | 575 | 596·2063 | 625 | 704·4025 | 675 | 821·6151 |
| 426 | 327·2503 | 476 | 408·5778 | 526 | 498·9216 | 576 | 598·2818 | 626 | 706·6584 | 676 | 824·0513 |
| 427 | 328·7885 | 477 | 410·2963 | 527 | 500·8205 | 577 | 600·3610 | 627 | 708·9179 | 677 | 826·4911 |
| 428 | 330·3303 | 478 | 412·0184 | 528 | 502·7229 | 578 | 602·4438 | 628 | 711·1810 | 678 | 828·9346 |
| 429 | 331·8757 | 479 | 413·7442 | 529 | 504·6290 | 579 | 604·5302 | 629 | 713·4477 | 679 | 831·3816 |
| 430 | 333·4247 | 480 | 415·4735 | 530 | 506·5387 | 580 | 606·6202 | 630 | 715·7180 | 680 | 833·8322 |
| 431 | 334·9773 | 481 | 417·2064 | 531 | 508·4519 | 581 | 608·7138 | 631 | 717·9920 | 681 | 836·2865 |
| 432 | 336·5335 | 482 | 418·9430 | 532 | 510·3688 | 582 | 610·8110 | 632 | 720·2695 | 682 | 838·7443 |
| 433 | 338·0934 | 483 | 420·6832 | 533 | 512·2893 | 583 | 612·9118 | 633 | 722·5506 | 683 | 841·2058 |
| 434 | 339·6568 | 484 | 422·4269 | 534 | 514·2134 | 584 | 615·0162 | 634 | 724·8354 | 684 | 843·6709 |
| 435 | 341·2238 | 485 | 424·1743 | 535 | 516·1411 | 585 | 617·1242 | 635 | 727·1237 | 685 | 846·1396 |
| 436 | 342·7945 | 486 | 425·9253 | 536 | 518·0724 | 586 | 619·2358 | 636 | 729·4157 | 686 | 848·6118 |
| 437 | 344·3687 | 487 | 427·6798 | 537 | 520·0073 | 587 | 621·3511 | 637 | 731·7112 | 687 | 851·0877 |
| 438 | 345·9466 | 488 | 429·4380 | 538 | 521·9458 | 588 | 623·4699 | 638 | 734·0104 | 688 | 853·5672 |
| 439 | 347·5281 | 489 | 431·1998 | 539 | 523·8879 | 589 | 625·5924 | 639 | 736·3132 | 689 | 856·0503 |
| 440 | 349·1132 | 490 | 432·9652 | 540 | 525·8337 | 590 | 627·7184 | 640 | 738·6196 | 690 | 858·5370 |
| 441 | 350·7018 | 491 | 434·7342 | 541 | 527·7830 | 591 | 629·8481 | 641 | 740·9295 | 691 | 861·0273 |
| 442 | 352·2941 | 492 | 436·5068 | 542 | 529·7359 | 592 | 631·9814 | 642 | 743·2431 | 692 | 863·5213 |
| 443 | 353·8900 | 493 | 438·2831 | 543 | 531·6925 | 593 | 634·1182 | 643 | 745·5603 | 693 | 866·0188 |
| 444 | 355·4895 | 494 | 440 0629 | 544 | 533·6526 | 594 | 636·2587 | 644 | 747·8812 | 694 | 868·5199 |
| 445 | 357·0926 | 495 | 441·8463 | 545 | 535·6164 | 595 | 638·4028 | 645 | 750·2056 | 695 | 871·0247 |
| 446 | 358·6993 | 496 | 443·6334 | 546 | 537·5838 | 596 | 640·5505 | 646 | 752·5336 | 696 | 873·5330 |
| 447 | 360·3097 | 497 | 445·4240 | 547 | 539·5547 | 597 | 642·7018 | 647 | 754·8652 | 697 | 876·0450 |
| 448 | 361·9236 | 498 | 447·2183 | 548 | 541·5293 | 598 | 644·8567 | 648 | 757·2005 | 698 | 878·5606 |
| 449 | 363·5411 | 499 | 449·0161 | 549 | 543·5075 | 599 | 647·0152 | 649 | 759·5393 | 699 | 881·0797 |
| 450 | 365·1623 | 500 | 450·8176 | 550 | 545·4893 | 600 | 649·1773 | 650 | 761·8817 | 700 | 883·6025 |

## TABLE *of the* AREAS *of* SEMI-SQUARES *in* IMPERIAL GALLONS.

*(Continued.)*

| Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. | Sides in inches. | Area. |
|---|---|---|---|---|---|---|---|---|---|
| 701 | 886·1289 | 721 | 937·4139 | 741 | 990·1415 | 761 | 1044·3118 | 781 | 1099·9246 |
| 702 | 888·6589 | 722 | 940·0160 | 742 | 992·8158 | 762 | 1047·0581 | 782 | 1102·7431 |
| 703 | 891·1925 | 723 | 942·6217 | 743 | 995·4936 | 763 | 1049·8081 | 783 | 1105·5653 |
| 704 | 893·7297 | 724 | 945·2311 | 744 | 998·1751 | 764 | 1052·5617 | 784 | 1108·3910 |
| 705 | 896·2705 | 725 | 947·8440 | 745 | 1000·8602 | 765 | 1055·3189 | 785 | 1111·2203 |
| 706 | 898·8149 | 726 | 950·4606 | 746 | 1003·5488 | 766 | 1058·0797 | 786 | 1114·0532 |
| 707 | 901·3629 | 727 | 953·0807 | 747 | 1006·2411 | 767 | 1060·8441 | 787 | 1116·8898 |
| 708 | 903·9145 | 728 | 955·7045 | 748 | 1008·9370 | 768 | 1063·6122 | 788 | 1119·7292 |
| 709 | 906·4698 | 729 | 958·3318 | 749 | 1011·6365 | 769 | 1066·3838 | 789 | 1122·5737 |
| 710 | 909·0286 | 730 | 960·9628 | 750 | 1014·3396 | 770 | 1069·1590 | 790 | 1125·4211 |
| 711 | 911·5911 | 731 | 963·5974 | 751 | 1017·0463 | 771 | 1071·9379 | 791 | 1128·2720 |
| 712 | 914·1571 | 732 | 966·2356 | 752 | 1019·7566 | 772 | 1074·7203 | 792 | 1131·1266 |
| 713 | 916·7268 | 733 | 968·8774 | 753 | 1022·4706 | 773 | 1077·5064 | 793 | 1133·9848 |
| 714 | 919·3000 | 734 | 971·5228 | 754 | 1025·1881 | 774 | 1080·2960 | 794 | 1136·8466 |
| 715 | 921·8769 | 735 | 974·1718 | 755 | 1027·9092 | 775 | 1083·0893 | 795 | 1139·7120 |
| 716 | 924·4574 | 736 | 976·8244 | 756 | 1030·6340 | 776 | 1085·8862 | 796 | 1142·5810 |
| 717 | 927·0415 | 737 | 979·4806 | 757 | 1033·3623 | 777 | 1088·6866 | 797 | 1145·4536 |
| 718 | 929·6292 | 738 | 982·1404 | 758 | 1036·0943 | 778 | 1091·4907 | 798 | 1148·3295 |
| 719 | 932·2205 | 739 | 984·8038 | 759 | 1038·8298 | 779 | 1094·2984 | 799 | 1151·2096 |
| 720 | 934·8154 | 740 | 987·4709 | 760 | 1041·5690 | 780 | 1097·1097 | 800 | 1154·0931 |

The use of this table will be seen by the rules and examples in p. 80, 119. 170, &c. It is calculated for inches and tenths as far as 100, and for inches only, when the number exceeds 100. Should there be tenths in any number exceeding 100, the proportional part for such tenths may be found correctly, as far as the third place of decimals, by multiplying the difference answering to the next greater and the next less number by the given number of tenths. In the government tables, from which the foregoing is extracted, the calculation is extended to 1000 inches and tenths.

### No. 2.

## TABLE *for finding the* AREAS *of* REGULAR POLYGONS.

| Name. | Number of sides. | Angle at the centre. | Area in inches, the side being unity. | Area in imperial gallons. | Area in imperial bushels. |
|---|---|---|---|---|---|
| | | Degrees. | | | |
| Trigon.... | 3 | 120 | ·4330127 | ·0015616 | ·0001952 |
| Tetragon.. | 4 | 90 | 1·0000000 | ·0036065 | ·0004508 |
| Pentagon.. | 5 | 72 | 1·7204774 | ·0062049 | ·0007756 |
| Hexagon.. | 6 | 60 | 2·5980762 | ·0093701 | ·0011713 |
| Heptagon . | 7 | $51\frac{3}{7}$ | 3·6339124 | ·0131058 | ·0016382 |
| Octagon .. | 8 | 45 | 4·8284271 | ·0174139 | ·0021767 |
| Nonagon.. | 9 | 40 | 6·1818242 | ·0222950 | ·0027869 |
| Decagon .. | 10 | 36 | 7·6942088 | ·0277495 | ·0034687 |
| Undecagon | 11 | $32\frac{8}{11}$ | 9·3656411 | ·0337775 | ·0042222 |
| Dodecagon | 12 | 30 | 11·1961524 | ·0403794 | ·0050474 |

## No. 3.

## TABLE *of the* AREAS *of* CIRCULAR SEGMENTS.

| Height. | Area. | Height. | Area. | Height. | Area. | Height. | Area. | Height. | Area. |
|---|---|---|---|---|---|---|---|---|---|
| ·001 | ·000042 | ·051 | ·015119 | ·101 | ·041476 | ·151 | ·074589 | ·201 | ·112624 |
| ·002 | ·000119 | ·052 | ·015561 | ·102 | ·042080 | ·152 | ·075306 | ·202 | ·113426 |
| ·003 | ·000219 | ·053 | ·016007 | ·103 | ·042687 | ·153 | ·076026 | ·203 | ·114230 |
| ·004 | ·000337 | ·054 | ·016457 | ·194 | ·043296 | ·154 | ·076747 | ·204 | ·115035 |
| ·005 | ·000470 | ·055 | ·016911 | ·105 | ·043908 | ·155 | ·077469 | ·205 | ·115842 |
| ·006 | ·000618 | ·056 | ·017369 | ·106 | ·044522 | ·156 | ·078194 | ·206 | ·116650 |
| ·007 | ·000779 | ·057 | ·017831 | ·107 | ·045139 | ·157 | ·078921 | ·207 | ·117460 |
| ·008 | ·000951 | ·058 | ·018296 | ·108 | ·045759 | ·158 | ·079649 | ·208 | ·118271 |
| ·009 | ·001135 | ·059 | ·018766 | ·109 | ·046381 | ·159 | ·080380 | ·209 | ·119084 |
| ·010 | ·001329 | ·060 | ·019239 | ·110 | ·047005 | ·160 | ·081112 | ·210 | ·119897 |
| ·011 | ·001533 | ·061 | ·019716 | ·111 | ·047632 | ·161 | ·081846 | ·211 | ·120712 |
| ·012 | ·001746 | ·062 | ·020196 | ·112 | ·048262 | ·162 | ·082582 | ·212 | ·121529 |
| ·013 | ·001969 | ·063 | ·020691 | ·113 | ·048894 | ·163 | ·083320 | ·213 | .122347 |
| ·014 | ·002199 | ·064 | ·021168 | ·114 | ·049528 | ·164 | ·084059 | ·214 | ·123167 |
| ·015 | ·002438 | ·065 | ·021659 | ·115 | ·050165 | ·165 | ·084801 | ·215 | ·123988 |
| ·016 | ·002685 | ·066 | ·022154 | ·116 | ·050804 | ·166 | ·085544 | ·216 | ·124810 |
| ·017 | ·002940 | ·067 | ·022652 | ·117 | ·051446 | ·167 | ·086289 | ·217 | ·125634 |
| ·018 | ·003202 | ·068 | ·023154 | ·118 | ·052090 | ·168 | ·087036 | ·218 | ·126459 |
| ·019 | ·003471 | ·069 | ·023659 | ·119 | ·052736 | ·169 | ·087785 | ·219 | ·127285 |
| ·020 | ·003748 | ·070 | ·024168 | ·120 | ·053385 | ·170 | ·088535 | ·220 | ·128113 |
| ·021 | ·004031 | ·071 | ·024680 | ·121 | ·054036 | ·171 | ·089287 | ·221 | ·128942 |
| ·022 | ·004322 | ·072 | ·025195 | ·122 | ·054689 | ·172 | ·090041 | ·222 | ·129773 |
| ·023 | ·004618 | ·073 | ·025714 | ·123 | ·055345 | ·173 | ·090797 | ·223 | ·130605 |
| ·024 | ·004921 | ·074 | ·026236 | ·124 | ·056003 | ·174 | ·091554 | ·224 | ·131438 |
| ·025 | ·005230 | ·075 | ·026761 | ·125 | ·056663 | ·175 | ·092313 | ·225 | ·132272 |
| ·026 | ·005546 | ·076 | ·027289 | ·126 | ·057326 | ·176 | ·093074 | ·226 | ·133108 |
| ·027 | ·005867 | ·077 | ·027821 | ·127 | ·057991 | ·177 | ·093836 | ·227 | ·133945 |
| ·028 | ·006194 | ·078 | ·028356 | ·128 | ·058658 | ·178 | ·094601 | ·228 | ·134784 |
| ·029 | ·006527 | ·079 | ·028894 | ·129 | ·059327 | ·179 | ·095366 | ·229 | ·135624 |
| ·030 | ·006865 | ·080 | ·029435 | ·130 | ·059999 | ·180 | ·096134 | ·230 | ·136465 |
| ·031 | ·007209 | ·081 | ·029979 | ·131 | ·060672 | ·181 | ·096904 | ·231 | ·137307 |
| ·032 | ·007558 | ·082 | ·030526 | ·132 | ·061348 | ·182 | ·097674 | ·232 | ·138150 |
| ·033 | ·007913 | ·083 | ·031076 | ·133 | ·062026 | ·183 | ·098447 | ·233 | ·138995 |
| ·034 | ·008273 | ·084 | ·031629 | ·134 | ·062707 | ·184 | ·099221 | ·234 | ·139841 |
| ·035 | ·008638 | ·085 | ·032186 | ·135 | ·063389 | ·185 | ·099997 | ·235 | ·140688 |
| ·036 | ·009008 | ·086 | ·032745 | ·136 | ·064074 | ·186 | ·100774 | ·236 | ·141537 |
| ·037 | ·009383 | ·087 | ·033307 | ·137 | ·064760 | ·187 | ·101553 | ·237 | ·142387 |
| ·038 | ·009763 | ·088 | ·033872 | ·138 | ·065449 | ·188 | ·102334 | ·238 | ·143238 |
| ·039 | ·010148 | ·089 | ·034441 | ·139 | ·066140 | ·189 | ·103116 | ·239 | ·144091 |
| ·040 | ·010537 | ·090 | ·035011 | ·140 | ·066833 | ·190 | ·103900 | ·240 | ·144944 |
| ·041 | ·010931 | ·091 | ·035585 | ·141 | ·067528 | ·191 | ·104685 | ·241 | ·145799 |
| ·042 | ·011330 | ·092 | ·036162 | ·142 | ·068225 | ·192 | ·105472 | ·242 | ·146655 |
| ·043 | ·011734 | ·093 | ·036741 | ·143 | ·068924 | ·193 | ·106261 | ·243 | ·147512 |
| ·044 | ·012142 | ·094 | ·037323 | ·144 | ·069625 | ·194 | ·107051 | ·244 | ·148371 |
| ·045 | ·012554 | ·095 | ·037909 | ·145 | ·070328 | ·195 | ·107842 | ·245 | ·149230 |
| ·046 | ·012971 | ·096 | ·038497 | ·146 | ·071033 | ·196 | ·108636 | ·246 | ·150091 |
| ·047 | ·013392 | ·097 | ·039087 | ·147 | ·071741 | ·197 | ·109431 | ·247 | ·150953 |
| ·048 | ·013818 | ·098 | ·039680 | ·148 | ·072450 | ·198 | ·110226 | ·248 | ·151816 |
| ·049 | ·014247 | ·099 | ·040276 | ·149 | ·073161 | ·199 | ·111025 | ·249 | ·152680 |
| ·050 | ·014681 | ·100 | ·040875 | ·150 | ·073874 | ·200 | ·111823 | ·250 | ·153546 |

## TABLE *of the* AREAS *of* CIRCULAR SEGMENTS.

*(Continued.)*

| Height. | Area. | Height. | Area. | Height. | Area. | Height. | Area | Height. | Area. |
|---|---|---|---|---|---|---|---|---|---|
| ·251 | ·154412 | ·301 | ·199085 | ·351 | ·245934 | ·401 | ·294349 | ·451 | ·343777 |
| ·252 | ·155280 | ·302 | ·200003 | ·352 | ·246889 | ·402 | ·295330 | ·452 | ·344772 |
| ·253 | ·156149 | ·303 | ·200922 | ·353 | ·247845 | ·403 | ·296311 | ·453 | ·345768 |
| ·254 | ·157019 | ·304 | ·201841 | ·354 | ·248801 | ·404 | ·297292 | ·454 | ·346764 |
| ·255 | ·157890 | ·305 | ·202761 | ·355 | ·249757 | ·405 | ·298273 | ·455 | ·347759 |
| ·256 | ·158762 | ·306 | ·203683 | ·356 | ·250715 | ·406 | ·299255 | ·456 | ·348755 |
| ·257 | ·159636 | ·307 | ·204605 | ·357 | ·251673 | ·407 | ·300238 | ·457 | ·349752 |
| ·258 | ·160510 | ·308 | ·205527 | ·358 | ·252631 | ·408 | ·301220 | ·458 | ·350748 |
| ·259 | ·161386 | ·309 | ·206451 | ·359 | ·253590 | ·409 | ·302203 | ·459 | ·351745 |
| ·260 | ·162263 | ·310 | ·207376 | ·360 | ·254550 | ·410 | ·303187 | ·460 | ·352742 |
| ·261 | ·163140 | ·311 | ·208301 | ·361 | ·255510 | ·411 | ·304171 | ·461 | ·353739 |
| ·262 | ·164019 | ·312 | ·209227 | ·362 | ·256471 | ·412 | ·305155 | ·462 | ·354736 |
| ·263 | ·164899 | ·313 | ·210154 | ·363 | ·257433 | ·413 | ·306140 | ·463 | ·355732 |
| ·264 | ·165780 | ·314 | ·211083 | ·364 | ·258395 | ·414 | ·307125 | ·464 | ·356730 |
| ·265 | ·166663 | ·315 | ·212011 | ·365 | ·259357 | ·415 | ·308110 | ·465 | ·357727 |
| ·266 | ·167546 | ·316 | ·212940 | ·366 | ·260320 | ·416 | ·309095 | ·466 | ·358725 |
| ·267 | ·168430 | ·317 | ·213871 | ·367 | ·261284 | ·417 | ·310081 | ·467 | ·359723 |
| ·268 | ·169316 | ·318 | ·214802 | ·368 | ·262248 | ·418 | ·311068 | ·468 | ·360721 |
| ·269 | ·170202 | ·319 | ·215733 | ·369 | ·263213 | ·419 | ·312054 | ·469 | ·361719 |
| ·270 | ·171089 | ·320 | ·216666 | ·370 | ·264178 | ·420 | ·313041 | ·470 | ·362717 |
| ·271 | ·171978 | ·321 | ·217599 | ·371 | ·265144 | ·421 | ·314029 | ·471 | ·363715 |
| ·272 | ·172867 | ·322 | ·218533 | ·372 | ·266111 | ·422 | ·315016 | ·472 | ·364713 |
| ·273 | ·173758 | ·323 | ·219468 | ·373 | ·267078 | ·423 | ·316004 | ·473 | ·365712 |
| ·274 | ·174649 | ·324 | ·220404 | ·374 | ·268045 | ·424 | ·316992 | ·474 | ·366710 |
| ·275 | ·175542 | ·325 | ·221341 | ·375 | ·269013 | ·425 | ·317981 | ·475 | ·367709 |
| ·276 | ·176435 | ·326 | ·222277 | ·376 | ·269982 | ·426 | ·318970 | ·476 | ·368708 |
| ·277 | ·177330 | ·327 | ·223215 | ·377 | ·270951 | ·427 | ·319959 | ·477 | ·369707 |
| ·278 | ·178225 | ·328 | ·224154 | ·378 | ·271920 | ·428 | ·320948 | ·478 | ·370706 |
| ·279 | ·179122 | ·329 | ·225093 | ·379 | ·272890 | ·429 | ·321938 | ·479 | ·371705 |
| ·280 | ·180019 | ·330 | ·226033 | ·380 | ·273861 | ·430 | ·322928 | .480 | ·372704 |
| ·281 | ·180918 | ·331 | ·226974 | ·381 | ·274832 | ·431 | ·323918 | ·481 | ·373703 |
| ·282 | ·181818 | ·332 | ·227915 | ·382 | ·275803 | ·432 | ·324909 | ·482 | ·374702 |
| ·283 | ·182718 | ·333 | ·228858 | ·383 | ·276775 | ·433 | ·325900 | ·483 | ·375702 |
| ·284 | ·183619 | ·334 | 229801 | ·384 | ·277748 | ·434 | ·326892 | ·484 | ·376702 |
| ·285 | ·184521 | ·335 | ·230745 | ·385 | ·278721 | ·435 | ·327882 | ·485 | .377701 |
| ·286 | ·185425 | 336 | ·231689 | ·386 | ·279694 | ·436 | ·328874 | ·486 | ·378701 |
| ·287 | ·186329 | 337 | ·232634 | ·387 | ·280668 | ·437 | ·329866 | ·487 | ·379700 |
| ·288 | ·187234 | ·338 | ·233580 | ·388 | ·281642 | ·438 | ·330858 | ·488 | ·380700 |
| ·289 | ·188140 | ·339 | ·234526 | ·389 | ·282617 | ·439 | ·331850 | ·489 | ·381699 |
| ·290 | ·189047 | ·340 | ·235473 | ·390 | ·283592 | ·440 | ·332843 | ·490 | ·382699 |
| ·291 | ·189955 | ·341 | ·236421 | ·391 | ·284568 | ·441 | ·333836 | ·491 | ·383699 |
| ·292 | ·190864 | ·342 | ·237369 | ·392 | ·285544 | ·442 | ·334829 | ·492 | ·384699 |
| ·293 | ·191775 | ·343 | ·238318 | ·393 | ·286521 | ·443 | ·335822 | ·493 | ·385699 |
| ·294 | ·192684 | ·344 | ·239268 | ·394 | ·287498 | ·444 | ·336816 | ·494 | ·386699 |
| ·295 | ·193596 | ·345 | ·240218 | ·395 | ·288476 | ·445 | ·337810 | ·495 | ·387699 |
| ·296 | ·194509 | ·346 | ·241169 | ·396 | ·289454 | ·446 | ·338804 | ·496 | ·388699 |
| ·297 | ·195422 | ·347 | ·242121 | ·397 | ·290432 | ·447 | ·339798 | ·497 | ·389699 |
| ·298 | ·196337 | ·348 | ·243074 | ·398 | ·291411 | ·448 | ·340793 | ·498 | ·390699 |
| ·299 | ·197252 | ·349 | ·244026 | ·399 | ·292390 | ·449 | ·341787 | ·499 | ·391699 |
| ·300 | ·198168 | ·350 | ·244980 | ·400 | ·293369 | ·450 | ·342782 | ·500 | ·392699 |

### No. 4.

### TABLE *of the* AREAS *of* CIRCLES *in* IMPERIAL GALLONS.

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·0028 | ·0034 | ·0040 | ·0047 | ·0055 | ·0063 | ·0072 | ·0081 | ·0091 | ·0102 |
| 2 | ·0113 | ·0124 | ·0137 | ·0149 | ·0163 | ·0177 | ·0191 | ·0206 | ·0222 | ·0238 |
| 3 | ·0254 | ·0272 | ·0290 | ·0308 | ·0327 | ·0346 | ·0367 | ·0387 | ·0409 | ·0430 |
| 4 | ·0453 | ·0476 | ·0499 | ·0523 | ·0548 | ·0573 | ·0599 | ·0625 | ·0652 | ·0680 |
| 5 | ·0708 | ·0736 | ·0765 | ·0795 | ·0825 | ·0856 | ·0888 | ·0920 | ·0952 | ·0986 |
| 6 | ·1019 | ·1053 | ·1088 | ·1124 | ·1160 | ·1196 | ·1233 | ·1271 | ·1309 | ·1348 |
| 7 | ·1387 | ·1427 | ·1468 | ·1509 | ·1551 | ·1593 | ·1636 | ·1679 | ·1723 | ·1767 |
| 8 | ·1812 | ·1858 | ·1904 | ·1951 | ·1998 | ·2046 | ·2094 | ·2143 | ·2193 | ·2243 |
| 9 | ·2294 | ·2345 | ·2397 | ·2449 | ·2502 | ·2556 | ·2610 | ·2665 | ·2720 | ·2776 |
| 10 | ·2832 | ·2889 | ·2947 | ·3005 | ·3063 | ·3122 | ·3182 | ·3243 | ·3303 | ·3365 |
| 11 | ·3427 | ·3490 | ·3553 | ·3616 | ·3681 | ·3746 | ·3811 | ·3877 | ·3944 | ·4011 |
| 12 | ·4078 | ·4147 | ·4215 | ·4285 | ·4355 | ·4425 | ·4496 | ·4568 | ·4640 | ·4713 |
| 13 | ·4787 | ·4860 | ·4935 | ·5010 | ·5086 | ·5162 | ·5239 | ·5316 | ·5394 | ·5472 |
| 14 | ·5551 | ·5631 | ·5711 | ·5792 | ·5873 | ·5955 | ·6037 | ·6120 | ·6204 | ·6288 |
| 15 | ·6373 | ·6458 | ·6544 | ·6630 | ·6717 | ·6805 | ·6893 | ·6982 | ·7071 | ·7161 |
| 16 | ·7251 | ·7342 | ·7433 | ·7525 | ·7618 | ·7711 | ·7805 | ·7899 | ·7994 | ·8090 |
| 17 | ·8186 | ·8282 | ·8379 | ·8477 | ·8575 | ·8674 | ·8774 | ·8874 | ·8974 | ·9075 |
| 18 | ·9177 | ·9279 | ·9382 | ·9485 | ·9589 | ·9694 | ·9799 | ·9905 | 1·0011 | 1·0118 |
| 19 | 1·0225 | 1·0333 | 1·0441 | 1·0551 | 1·0660 | 1·0770 | 1·0881 | 1·0992 | 1·1104 | 1·1217 |
| 20 | 1·1330 | 1·1443 | 1·1558 | 1·1672 | 1·1788 | 1·1903 | 1·2020 | 1·2137 | 1·2254 | 1·2372 |
| 21 | 1·2491 | 1·2610 | 1·2730 | 1·2851 | 1·2972 | 1·3093 | 1·3215 | 1·3338 | 1·3461 | 1·3585 |
| 22 | 1·3709 | 1·3834 | 1·3960 | 1·4086 | 1·4212 | 1·4339 | 1·4467 | 1·4595 | 1·4724 | 1·4854 |
| 23 | 1·4984 | 1·5114 | 1·5246 | 1·5377 | 1·5510 | 1·5642 | 1·5776 | 1·5910 | 1·6044 | 1·6179 |
| 24 | 1·6315 | 1·6451 | 1·6588 | 1·6726 | 1·6863 | 1·7002 | 1·7141 | 1·7281 | 1·7421 | 1·7562 |
| 25 | 1·7703 | 1·7845 | 1·7987 | 1·8131 | 1·8274 | 1·8418 | 1·8563 | 1·8708 | 1·8854 | 1·9001 |
| 26 | 1·9148 | 1·9295 | 1·9443 | 1·9592 | 1·9741 | 1·9891 | 2·0042 | 2·0193 | 2·0344 | 2·0496 |
| 27 | 2·0649 | 2·0802 | 2·0956 | 2·1110 | 2·1265 | 2·1421 | 2·1577 | 2·1734 | 2·1891 | 2·2049 |
| 28 | 2·2207 | 2·2366 | 2·2525 | 2·2685 | 2·2846 | 2·3007 | 2·3169 | 2·3331 | 2·3494 | 2·3657 |
| 29 | 2·3821 | 2·3986 | 2·4151 | 2·4317 | 2·4483 | 2·4650 | 2·4817 | 2·4985 | 2·5154 | 2·5323 |
| 30 | 2·5493 | 2·5663 | 2·5834 | 2·6005 | 2·6177 | 2·6349 | 2·6523 | 2·6696 | 2·6870 | 2·7045 |
| 31 | 2·7221 | 2·7396 | 2·7573 | 2·7750 | 2·7928 | 2·8106 | 2·8284 | 2·8464 | 2·8644 | 2·8824 |
| 32 | 2·9005 | 2·9187 | 2·9369 | 2·9551 | 2·9735 | 2·9919 | 3·0103 | 3·0288 | 3·0473 | 3·0660 |
| 33 | 3·0847 | 3·1033 | 3·1221 | 3·1410 | 3·1599 | 3·1788 | 3·1978 | 3·2169 | 3·2360 | 3·2552 |
| 34 | 3·2744 | 3·2937 | 3·3130 | 3·3324 | 3·3519 | 3·3714 | 3·3910 | 3·4106 | 3·4303 | 3·4500 |
| 35 | 3·4698 | 3·4897 | 3·5096 | 3·5296 | 3·5496 | 3·5697 | 3·5898 | 3·6100 | 3·6303 | 3·6506 |
| 36 | 3·6710 | 3·6914 | 3·7119 | 3·7324 | 3·7530 | 3·7736 | 3·7943 | 3·8151 | 3·8359 | 3·8568 |
| 37 | 3·8777 | 3·8987 | 3·9198 | 3·9409 | 3·9620 | 3·9833 | 4·0045 | 4·0259 | 4·0472 | 4·0687 |
| 38 | 4·0902 | 4·1117 | 4·1334 | 4·1550 | 4·1767 | 4·1985 | 4·2204 | 4·2423 | 4·2642 | 4·2862 |
| 39 | 4·3083 | 4·3304 | 4·3526 | 4·3748 | 4·3971 | 4·4195 | 4·4419 | 4·4643 | 4·4869 | 4·5094 |
| 40 | 4·5321 | 4·5548 | 4·5775 | 4·6003 | 4·6232 | 4·6461 | 4·6690 | 4·6921 | 4·7152 | 4·7383 |
| 41 | 4·7615 | 4·7848 | 4·8081 | 4·8314 | 4·8549 | 4·8783 | 4·9019 | 4·9255 | 4·9491 | 4·9728 |
| 42 | 4·9966 | 5·0204 | 5·0443 | 5·0682 | 5·0922 | 5·1163 | 5·1404 | 5·1645 | 5·1888 | 5·2130 |
| 43 | 5·2374 | 5·2618 | 5·2862 | 5·3107 | 5·3353 | 5·3599 | 5·3846 | 5·4093 | 5·4341 | 5·4589 |
| 44 | 5·4838 | 5·5088 | 5·5338 | 5·5588 | 5·5840 | 5·6091 | 5·6344 | 5·6597 | 5·6850 | 5·7104 |
| 45 | 5·7359 | 5·7614 | 5·7870 | 5·8126 | 5·8383 | 5·8641 | 5·8899 | 5·9157 | 5·9417 | 5·9676 |
| 46 | 5·9937 | 6·0198 | 6·0459 | 6·0721 | 6·0984 | 6·1247 | 6·1510 | 6·1775 | 6·2040 | 6·2305 |
| 47 | 6·2571 | 6·2838 | 6.3105 | 6·3372 | 6·3641 | 6·3909 | 6·4179 | 6·4449 | 6·4719 | 6·4990 |
| 48 | 6·5262 | 6·5534 | 6·5807 | 6·6080 | 6·6354 | 6·6629 | 6·6904 | 6·7179 | 6·7455 | 6·7732 |
| 49 | 6·8010 | 6·8287 | 6·8566 | 6·8845 | 6·9124 | 6·9405 | 6·9685 | 6·9967 | 7·0248 | 7·0531 |
| 50 | 7·0814 | 7·1097 | 7·1381 | 7·1666 | 7·1951 | 7·2237 | 7·2524 | 7·2810 | 7·3098 | 7·3386 |

## TABLE *of the* AREAS *of* CIRCLES *in* IMPERIAL GALLONS.

*(Continued.)*

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 7·3675 | 7·3964 | 7·4254 | 7·4544 | 7·4835 | 7·5126 | 7·5418 | 7·5711 | 7·6004 | 7·6298 |
| 52 | 7·6592 | 7·6887 | 7·7183 | 7·7479 | 7·7775 | 7·8072 | 7·8370 | 7·8668 | 7·8967 | 7·9266 |
| 53 | 7·9566 | 7·9867 | 8·0168 | 8·0470 | 8·0772 | 8·1075 | 8·1378 | 8·1682 | 8·1987 | 8·2292 |
| 54 | 8·2597 | 8·2903 | 8·3210 | 8·3518 | 8·3825 | 8·4134 | 8·4443 | 8·4753 | 8·5063 | 8·5373 |
| 55 | 8·5685 | 8·5997 | 8·6309 | 8·6622 | 8·6936 | 8·7250 | 8·7564 | 8·7880 | 8·8196 | 8·8512 |
| 56 | 8·8829 | 8·9146 | 8·9465 | 8·9783 | 9·0102 | 9·0422 | 9·0743 | 9·1064 | 9·1385 | 9·1707 |
| 57 | 9·2030 | 9·2353 | 9·2677 | 9·3001 | 9·3326 | 9·3651 | 9·3977 | 9·4304 | 9·4631 | 9·4959 |
| 58 | 9·5287 | 9·5616 | 9·5945 | 9·6275 | 9·6606 | 9·6937 | 9·7269 | 9·7601 | 9·7934 | 9·8267 |
| 59 | 9·8601 | 9·8936 | 9·9271 | 9·9607 | 9·9943 | 10·0280 | 10·0617 | 10·0955 | 10·1293 | 10·1632 |
| 60 | 10·1972 | 10·2312 | 10·2653 | 10·2994 | 10·3336 | 10·3679 | 10·4022 | 10·4365 | 10·4709 | 10·5054 |
| 61 | 10·5399 | 10·5745 | 10·6092 | 10·6439 | 10·6786 | 10·7134 | 10·7483 | 10·7832 | 10·8182 | 10·8533 |
| 62 | 10·8884 | 10·9235 | 10·9587 | 10·9940 | 11·0293 | 11·0647 | 11·1001 | 11·1356 | 11·1712 | 11·2068 |
| 63 | 11·2424 | 11·2781 | 11·3139 | 11·3497 | 11·3856 | 11·4216 | 11·4576 | 11·4936 | 11·5298 | 11·5659 |
| 64 | 11·6022 | 11·6384 | 11·6748 | 11·7112 | 11·7476 | 11·7842 | 11·8207 | 11·8573 | 11·8940 | 11·9308 |
| 65 | 11·9676 | 12·0044 | 12·0413 | 12·0783 | 12·1153 | 12·1524 | 12·1895 | 12·2267 | 12·2640 | 12·3013 |
| 66 | 12·3386 | 12·3760 | 12·4135 | 12·4511 | 12·4886 | 12·5263 | 12·5640 | 12·6017 | 12·6396 | 12·6774 |
| 67 | 12·7154 | 12·7533 | 12·7914 | 12·8295 | 12·8676 | 12·9058 | 12·9441 | 12·9824 | 13·0208 | 13·0593 |
| 68 | 13·0978 | 13·1363 | 13·1749 | 13·2136 | 13·2523 | 13·2911 | 13·3299 | 13·3688 | 13·4078 | 13·4468 |
| 69 | 13·4858 | 13·5249 | 13·5641 | 13·6033 | 13·6426 | 13·6820 | 13·7214 | 13·7608 | 13·8003 | 13·8399 |
| 70 | 13·8795 | 13·9192 | 13·9590 | 13·9988 | 14·0386 | 14·0785 | 14·1185 | 14·1585 | 14·1986 | 14·2387 |
| 71 | 14·2789 | 14·3192 | 14·3595 | 14·3999 | 14·4403 | 14·4808 | 14·5213 | 14·5619 | 14·6025 | 14·6432 |
| 72 | 14·6840 | 14·7248 | 14·7657 | 14·8066 | 14·8476 | 14·8886 | 14·9297 | 14·9709 | 15·0121 | 15·0534 |
| 73 | 15·0947 | 15·1361 | 15·1775 | 15·2190 | 15·2606 | 15·3022 | 15·3439 | 15·3856 | 15·4274 | 15·4692 |
| 74 | 15·5111 | 15·5531 | 15·5951 | 15·6371 | 15·6792 | 15·7214 | 15·7637 | 15·8059 | 15·8483 | 15·8907 |
| 75 | 15·9332 | 15·9757 | 16·0182 | 16·0609 | 16·1036 | 16·1463 | 16·1891 | 16·2320 | 16·2749 | 16·3179 |
| 76 | 16·3609 | 16·4040 | 16·4471 | 16·4903 | 16·5336 | 16·5769 | 16·6202 | 16·6637 | 16·7071 | 16·7507 |
| 77 | 16·7943 | 16·8379 | 16·8816 | 16·9254 | 16·9692 | 17·0131 | 17·0570 | 17·1010 | 17·1450 | 17·1891 |
| 78 | 17·2333 | 17·2775 | 17·3218 | 17·3661 | 17·4105 | 17·4550 | 17·4995 | 17·5440 | 17·5886 | 17·6333 |
| 79 | 17·6780 | 17·7228 | 17·7676 | 17·8125 | 17·8575 | 17·9025 | 17·9476 | 17·9927 | 18·0379 | 18·0831 |
| 80 | 18·1284 | 18·1738 | 18·2192 | 18·2646 | 18·3101 | 18·3557 | 18·4013 | 18·4470 | 18·4928 | 18·5386 |
| 81 | 18·5844 | 18·6304 | 18·6763 | 18·7224 | 18·7684 | 18·8146 | 18·8608 | 18·9070 | 18·9534 | 18·9997 |
| 82 | 19·0462 | 19·0926 | 19·1392 | 19·1858 | 19·2324 | 19·2791 | 19·3259 | 19·3727 | 19·4196 | 19·4665 |
| 83 | 19·5135 | 19·5606 | 19·6077 | 19·6548 | 19·7021 | 19·7493 | 19·7967 | 19·8441 | 19·8915 | 19·9390 |
| 84 | 19·9866 | 20·0342 | 20·0819 | 20·1296 | 20·1774 | 20·2252 | 20·2731 | 20·3211 | 20·3691 | 20·4171 |
| 85 | 20·4653 | 20·5135 | 20·5617 | 20·6100 | 20·6583 | 20·7067 | 20·7552 | 20·8037 | 20·8523 | 20·9009 |
| 86 | 20·9496 | 20·9984 | 21·0472 | 21·0961 | 21·1450 | 21·1940 | 21·2430 | 21·2921 | 21·3412 | 21·3904 |
| 87 | 21·4397 | 21·4890 | 21·5384 | 21·5878 | 21·6373 | 21·6868 | 21·7364 | 21·7861 | 21·8358 | 21·8856 |
| 88 | 21·9354 | 21·9853 | 22·0352 | 22·0852 | 22·1352 | 22·1854 | 22·2355 | 22·2857 | 22·3360 | 22·3863 |
| 89 | 22·4367 | 22·4872 | 22·5377 | 22·5883 | 22·6389 | 22·6895 | 22·7403 | 22·7911 | 22·8419 | 22·8928 |
| 90 | 22·9438 | 22·9948 | 23·0459 | 23·0970 | 23·1482 | 23·1994 | 23·2507 | 23·3021 | 23·3535 | 23·4049 |
| 91 | 23·4565 | 23·5080 | 23·5597 | 23·6114 | 23·6631 | 23·7149 | 23·7668 | 23·8187 | 23·8707 | 23·9227 |
| 92 | 23·9748 | 24·0270 | 24·0792 | 24·1314 | 24·1838 | 24·2361 | 24·2886 | 24·3411 | 24·3936 | 24·4462 |
| 93 | 24·4989 | 24·5516 | 24·6043 | 24·6572 | 24·7100 | 24·7630 | 24·8160 | 24·8690 | 24·9222 | 24·9753 |
| 94 | 25·0285 | 25·0818 | 25·1352 | 25·1886 | 25·2420 | 25·2955 | 25·3491 | 25·4027 | 25·4564 | 25·5101 |
| 95 | 25·5639 | 25·6177 | 25·6717 | 25·7256 | 25·7796 | 25·8337 | 25·8878 | 25·9420 | 25·9963 | 26·0506 |
| 96 | 26·1049 | 26·1593 | 26·2138 | 26·2683 | 26·3229 | 26·3776 | 26·4323 | 26·4870 | 26·5418 | 26·5967 |
| 97 | 26·6516 | 26·7066 | 26·7616 | 26·8167 | 26·8719 | 26·9271 | 26·9823 | 27·0377 | 27·0930 | 27·1485 |
| 98 | 27·2040 | 27·2595 | 27·3151 | 27·3708 | 27·4265 | 27·4823 | 27·5381 | 27·5940 | 27·6499 | 27·7059 |
| 99 | 27·7620 | 27·8181 | 27·8743 | 27·9305 | 27·9868 | 28·0431 | 28·0995 | 28·1560 | 28·2125 | 28·2690 |
| 100 | 28·3257 | 28·3823 | 28·4391 | 28·4959 | 28·5527 | 28·6096 | 28·6666 | 28·7236 | 28·7807 | 28·8378 |

### TABLE *of the* AREAS *of* CIRCLES IN IMPERIAL GALLONS.

*(Continued.)*

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 28·8950 | 28·9522 | 29·0096 | 29·0669 | 29·1243 | 29·1818 | 29·2393 | 29·2969 | 29·3546 | 29·4123 |
| 102 | 29·4700 | 29·5278 | 29·5857 | 29·6436 | 29·7016 | 29·7596 | 29·8177 | 29·8759 | 29·9341 | 29·9924 |
| 103 | 30·0507 | 30·1091 | 30·1675 | 30·2260 | 30·2845 | 30·3432 | 30·4018 | 30·4605 | 30·5193 | 30·5781 |
| 104 | 30·6370 | 30·6960 | 30·7550 | 30·8140 | 30·8732 | 30·9323 | 30·9916 | 31·0508 | 31·1102 | 31·1696 |
| 105 | 31·2290 | 31·2886 | 31·3481 | 31·4077 | 31·4674 | 31·5272 | 31·5870 | 31·6468 | 31·7067 | 31·7667 |
| 106 | 31·8267 | 31·8868 | 31·9469 | 32·0071 | 32·0674 | 32·1277 | 32·1880 | 32·2485 | 32·3089 | 32·3696 |
| 107 | 32·4301 | 32·4907 | 32·5514 | 32·6122 | 32·6730 | 32·7338 | 32·7948 | 32·8558 | 32·9168 | 32·9779 |
| 108 | 33·0391 | 33·1003 | 33·1615 | 33·2229 | 33·2842 | 33·3457 | 33·4072 | 33·4687 | 33·5303 | 33·5920 |
| 109 | 33·6537 | 33·7155 | 33·7773 | 33·8392 | 33·9012 | 33·9632 | 34·0252 | 34·0874 | 34·1495 | 34·2118 |
| 110 | 34·2741 | 34·3364 | 34·3988 | 34·4613 | 34·5238 | 34·5863 | 34·6490 | 34·7117 | 34·7744 | 34·8372 |
| 111 | 34·9001 | 34·9630 | 35·0259 | 35·0890 | 35·1520 | 35·2152 | 35·2784 | 35·3416 | 35·4049 | 35·4683 |
| 112 | 35·5317 | 35·5952 | 35·6587 | 35·7223 | 35·7860 | 35·8497 | 35·9134 | 35·9772 | 36·0411 | 36·1051 |
| 113 | 36·1690 | 36·2331 | 36·2972 | 36·3613 | 36·4256 | 36·4898 | 36·5542 | 36·6185 | 36·6830 | 36·7475 |
| 114 | 36·8120 | 36·8766 | 36·9413 | 37·0060 | 37·0708 | 37·1357 | 37·2006 | 37·2655 | 37·3305 | 37·3956 |
| 115 | 37·4607 | 37·5259 | 37·5911 | 37·6564 | 37·7217 | 37·7871 | 37·8526 | 37·9181 | 37·9837 | 38·0493 |
| 116 | 38·1150 | 38·1808 | 38·2466 | 38·3124 | 38·3783 | 38·4443 | 38·5103 | 38·5764 | 38·6426 | 38·7088 |
| 117 | 38·7750 | 38·8413 | 38·9077 | 38·9741 | 39·0406 | 39·1071 | 39·1737 | 39·2404 | 39·3071 | 39·3738 |
| 118 | 39·4407 | 39·5075 | 39·5745 | 39·6415 | 39·7085 | 39·7756 | 39·8428 | 39·9100 | 39·9773 | 40·0446 |
| 119 | 40·1120 | 40·1794 | 40·2469 | 40·3145 | 40·3821 | 40·4498 | 40·5175 | 40·5853 | 40·6531 | 40·7210 |
| 120 | 40·7890 | 40 8570 | 40·9250 | 40·9932 | 41·0613 | 41·1296 | 41·1979 | 41·2662 | 41·3346 | 41·4031 |
| 121 | 41·4716 | 41·5402 | 41·6088 | 41·6775 | 41·7463 | 41·8151 | 41·8839 | 41·9528 | 42·0218 | 42·0908 |
| 122 | 42·1599 | 42·2291 | 42·2983 | 42·3675 | 42·4368 | 42·5062 | 42·5756 | 42·6451 | 42·7147 | 42·7843 |
| 123 | 42·8539 | 42·9236 | 42·9934 | 43·0632 | 43·1331 | 43·2030 | 43·2730 | 43·3431 | 43·4132 | 43·4833 |
| 124 | 43·5536 | 43·6238 | 43·6942 | 43·7646 | 43·8350 | 43·9055 | 43·9761 | 44·0467 | 44·1173 | 44·1881 |
| 125 | 44·2589 | 44·3297 | 44·4006 | 44·4716 | 44·5426 | 44·6136 | 44·6848 | 44·7560 | 44·8272 | 44·8985 |
| 126 | 44·9698 | 45·0412 | 45·1127 | 45·1842 | 45·2558 | 45·3275 | 45·3991 | 45·4709 | 45·5427 | 45·6146 |
| 127 | 45·6865 | 45·7585 | 45·8305 | 45·9026 | 45·9747 | 46·0469 | 46·1192 | 46·1915 | 46·2639 | 46·3363 |
| 128 | 46·4088 | 46·4813 | 46·5539 | 46·6266 | 46·6993 | 46·7721 | 46·8449 | 46·9178 | 46·9907 | 47·0637 |
| 129 | 47·1368 | 47·2099 | 47·2830 | 47·3563 | 47·4295 | 47·5029 | 47·5763 | 47·6497 | 47·7232 | 47·7968 |
| 130 | 47·8704 | 47·9441 | 48·0178 | 48·0916 | 48·1654 | 48·2393 | 48·3133 | 48·3873 | 48·4614 | 48·5355 |
| 131 | 48·6097 | 48·6839 | 48·7582 | 48·8326 | 48·9070 | 48·9815 | 49·0560 | 49·1306 | 49·2052 | 49·2799 |
| 132 | 49·3547 | 49·4295 | 49·5043 | 49·5793 | 49·6542 | 49·7293 | 49·8044 | 49·8795 | 49·9547 | 50·0300 |
| 133 | 50·1053 | 50·1807 | 50·2561 | 50·3316 | 50·4071 | 50·4827 | 50·5584 | 50·6341 | 50·7099 | 50·7857 |
| 134 | 50·8616 | 50·9375 | 51·0135 | 51·0896 | 51·1657 | 51·2419 | 51·3181 | 51·3944 | 51·4707 | 51·5471 |
| 135 | 51·6235 | 51·7001 | 51·7766 | 51·8532 | 51·9299 | 52·0067 | 52·0834 | 52·1603 | 52·2372 | 52·3142 |
| 136 | 52·3912 | 52·4682 | 52·5454 | 52·6226 | 52·6998 | 52·7771 | 52·8545 | 52·9319 | 53·0094 | 53·0869 |
| 137 | 53·1645 | 53·2421 | 53·3198 | 53·3976 | 53·4754 | 53·5532 | 53·6312 | 53·7091 | 53·7872 | 53·8653 |
| 138 | 53·9434 | 54·0216 | 54·0999 | 54·1782 | 54·2566 | 54·3350 | 54·4135 | 54·4921 | 54·5707 | 54·6493 |
| 139 | 54·7280 | 54·8068 | 54·8856 | 54·9645 | 55·0435 | 55·1225 | 55·2015 | 55·2807 | 55·3598 | 55·4390 |
| 140 | 55·5183 | 55·5977 | 55·6771 | 55·7565 | 55·8360 | 55·9156 | 55·9952 | 56·0749 | 56·1546 | 56·2344 |
| 141 | 56·3143 | 56·3942 | 56·4742 | 56·5542 | 56·6343 | 56·7144 | 56·7946 | 56·8748 | 56·9551 | 57·0355 |
| 142 | 57·1159 | 57·1964 | 57·2769 | 57·3575 | 57·4381 | 57·5188 | 57·5996 | 57·6804 | 57·7613 | 57·8422 |
| 143 | 57·9232 | 58·0042 | 58·0853 | 58·1665 | 58·2477 | 58·3290 | 58·4103 | 58·4917 | 58·5731 | 58·6546 |
| 144 | 58·7361 | 58·8177 | 58·8994 | 58·9811 | 59·0629 | 59·1447 | 59·2266 | 59·3086 | 59·3906 | 59·4726 |
| 145 | 59·5547 | 59·6369 | 59·7191 | 59·8014 | 59·8838 | 59·9662 | 60·0486 | 60·1311 | 60·2137 | 60·2963 |
| 146 | 60·3790 | 60·4618 | 60·5446 | 60·6274 | 60·7103 | 60·7933 | 60·8763 | 60·9594 | 61·0425 | 61·1257 |
| 147 | 61·2090 | 61·2923 | 61·3756 | 61·4591 | 61·5425 | 61·6261 | 61·7097 | 61·7933 | 61·8770 | 61·9608 |
| 148 | 62·0446 | 62·1284 | 62·2124 | 62·2964 | 62·3804 | 62·4645 | 62·5487 | 62·6329 | 62·7171 | 62·8015 |
| 149 | 62·8858 | 62·9703 | 63·0548 | 63·1393 | 63·2239 | 63·3086 | 63·3933 | 63·4781 | 63·5629 | 63·6478 |
| 150 | 63·7328 | 63·8178 | 63·9029 | 63·9880 | 64·0731 | 64·1584 | 64·2437 | 64·3290 | 64·4144 | 64·4999 |

## TABLE *of the* AREAS *of* CIRCLES *in* IMPERIAL GALLONS.

*(Continued.)*

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 151 | 64·5854 | 64·6710 | 64·7566 | 64·8423 | 64·9280 | 65·0138 | 65·0997 | 65·1856 | 65·2716 | 65·3576 |
| 152 | 65·4437 | 65·5298 | 65·6160 | 65·7022 | 65·7886 | 65·8749 | 65·9613 | 66·0478 | 66·1344 | 66·2209 |
| 153 | 66·3076 | 66·3943 | 66·4811 | 66·5679 | 66·6548 | 66·7417 | 66·8287 | 66·9157 | 67·0028 | 67·0900 |
| 154 | 67·1772 | 67·2645 | 67·3518 | 67·4392 | 67·5266 | 67·6141 | 67·7017 | 67·7893 | 67·8770 | 67·9647 |
| 155 | 68·0525 | 68·1403 | 68·2282 | 68·3161 | 68·4041 | 68·4922 | 68·5803 | 68·6685 | 68·7567 | 68·8450 |
| 156 | 68·9334 | 69·0218 | 69·1103 | 69·1988 | 69·2873 | 69·3760 | 69·4647 | 69·5534 | 69·6422 | 69·7311 |
| 157 | 69·8200 | 69·9090 | 69·9980 | 70·0871 | 70·1762 | 70·2654 | 70·3547 | 70·4440 | 70·5333 | 70·6228 |
| 158 | 70·7122 | 70·8018 | 70·8914 | 70·9810 | 71·0707 | 71·1605 | 71·2503 | 71·3402 | 71·4301 | 71·5201 |
| 159 | 71·6102 | 71·7003 | 71·7904 | 71·8806 | 71·9709 | 72·0613 | 72·1516 | 72·2421 | 72·3326 | 72·4231 |
| 160 | 72·5138 | 72·6044 | 72·6952 | 72·7859 | 72·8768 | 72·9677 | 73·0586 | 73 1496 | 73·2407 | 73·3318 |
| 161 | 73·4230 | 73·5142 | 73·6055 | 73·6969 | 73·7883 | 73·8798 | 73·9713 | 74·0629 | 74·1545 | 74·2462 |
| 162 | 74·3379 | 74·4297 | 74·5216 | 74·6135 | 74·7055 | 74·7975 | 74·8896 | 74·9817 | 75·0739 | 75·1662 |
| 163 | 75·2585 | 75·3509 | 75·4433 | 75·5358 | 75·6283 | 75·7209 | 75·8136 | 75·9063 | 75·9991 | 76·0919 |
| 164 | 76·1848 | 76·2777 | 76·3707 | 76·4637 | 76·5569 | 76·6500 | 76·7432 | 76·8365 | 76·9298 | 77·0232 |
| 165 | 77·1167 | 77·2102 | 77·3037 | 77·3974 | 77·4910 | 77·5848 | 77·6786 | 77·7724 | 77·8663 | 77·9603 |
| 166 | 78·0543 | 78·1483 | 78·2425 | 78·3366 | 78·4309 | 78·5252 | 78·6195 | 78·7139 | 78·8084 | 78·9029 |
| 167 | 78·9975 | 79·0921 | 79·1868 | 79·2816 | 79·3764 | 79·4713 | 79·5662 | 79·6612 | 79·7562 | 79·8513 |
| 168 | 79·9464 | 80·0416 | 80·1369 | 80·2322 | 80·3276 | 80·4230 | 80·5185 | 80·6140 | 80·7096 | 80·8053 |
| 169 | 80·9010 | 80·9968 | 81·0926 | 81·1885 | 81·2844 | 81·3804 | 81·4765 | 81·5726 | 81·6687 | 81·7650 |
| 170 | 81·8612 | 81·9576 | 82·0540 | 82·1504 | 82·2469 | 82·3435 | 82·4401 | 82·5368 | 82·6335 | 82·7303 |
| 171 | 82·8271 | 82·9240 | 83·0210 | 83·1180 | 83·2151 | 83·3122 | 83·4094 | 83·5067 | 83·6039 | 83·7013 |
| 172 | 83·7987 | 83·8962 | 83·9937 | 84·0913 | 84·1889 | 84·2866 | 84·3844 | 84·4822 | 84·5801 | 84·6780 |
| 173 | 84·7760 | 84·8740 | 84·9721 | 85·0702 | 85·1684 | 85·2667 | 85·3650 | 85·4634 | 85·5618 | 85·6603 |
| 174 | 85·7589 | 85·8575 | 85·9561 | 86·0548 | 86·1536 | 86·2524 | 86·3513 | 86·4503 | 86·5493 | 86·6483 |
| 175 | 86·7474 | 86·8466 | 86·9458 | 87·0451 | 87·1444 | 87·2438 | 87·3433 | 87·4428 | 87·5424 | 87·6420 |
| 176 | 87·7417 | 87·8414 | 87·9412 | 88·0410 | 88·1409 | 88·2409 | 88·3409 | 88·4410 | 88·5411 | 88·6413 |
| 177 | 88·7416 | 88·8419 | 88·9422 | 89·0426 | 89·1431 | 89·2436 | 89·3442 | 89·4449 | 89·5455 | 89·6463 |
| 178 | 89·7471 | 89·8480 | 89·9489 | 90·0499 | 90·1509 | 90·2520 | 90·3532 | 90·4544 | 90·5556 | 90·6570 |
| 179 | 90·7583 | 90·8598 | 90·9613 | 91·0628 | 91·1644 | 91·2661 | 91·3678 | 91·4696 | 91·5714 | 91·6733 |
| 180 | 91·7752 | 91·8772 | 91·9793 | 92·0814 | 92·1836 | 92·2858 | 92·3881 | 92·4904 | 92·5928 | 92·6953 |
| 181 | 92·7978 | 92·9004 | 93·0030 | 93·1057 | 93·2084 | 93·3112 | 93·4140 | 93·5170 | 93·6199 | 93·7229 |
| 182 | 93·8260 | 93·9292 | 94·0323 | 94·1356 | 94·2389 | 94·3423 | 94·4457 | 94·5491 | 94·6527 | 94·7563 |
| 183 | 94·8599 | 94·9636 | 95·0674 | 95·1712 | 95·2750 | 95·3790 | 95·4830 | 95·5870 | 95·6911 | 95·7952 |
| 184 | 95·8995 | 96·0037 | 96·1080 | 96·2124 | 96·3169 | 96·4214 | 96·5259 | 96·6305 | 96·7352 | 96·8399 |
| 185 | 96·9447 | 97·0495 | 97·1544 | 97·2593 | 97·3644 | 97·4694 | 97·5745 | 97·6797 | 97·7849 | 97·8902 |
| 186 | 97·9956 | 98·1010 | 98·2064 | 98·3119 | 98·4175 | 98·5231 | 98·6288 | 98·7345 | 98·8403 | 98·9462 |
| 187 | 99·0521 | 99·1581 | 99·2641 | 99·3702 | 99·4763 | 99·5825 | 99·6888 | 99·7951 | 99·9014 | 100·007 |
| 188 | 100·114 | 100·220 | 100·327 | 100·434 | 100·540 | 100·647 | 100·754 | 100·861 | 100·968 | 101·075 |
| 189 | 101·182 | 101·289 | 101·396 | 101·503 | 101·610 | 101·718 | 101·825 | 101·933 | 102·040 | 102·148 |
| 190 | 102·255 | 102·363 | 102·471 | 102·578 | 102·686 | 102·794 | 102·902 | 103·010 | 103·118 | 103·226 |
| 191 | 103·335 | 103·443 | 103·551 | 103·659 | 103·768 | 103·876 | 103·985 | 104·093 | 104·202 | 104·311 |
| 192 | 104·419 | 104·528 | 104·637 | 104·746 | 104·855 | 104·964 | 105·073 | 105·182 | 105·291 | 105·401 |
| 193 | 105·510 | 105·619 | 105·729 | 105 838 | 105·948 | 106·057 | 106·167 | 106·277 | 106·386 | 106·496 |
| 194 | 106·606 | 106·716 | 106·826 | 106·936 | 107·046 | 107·156 | 107·267 | 107·377 | 107·487 | 107·598 |
| 195 | 107·708 | 107·818 | 107·929 | 108·040 | 108·150 | 108·261 | 108·372 | 108·483 | 108·594 | 108·705 |
| 196 | 108·816 | 108·927 | 109·038 | 109·149 | 109·260 | 109·371 | 109·483 | 109·594 | 109·706 | 109·817 |
| 197 | 109·929 | 110·040 | 110·152 | 110·264 | 110·376 | 110·487 | 110·599 | 110·711 | 110·823 | 110·935 |
| 198 | 111·048 | 111·160 | 111·272 | 111·384 | 111·497 | 111·609 | 111·722 | 111·834 | 111·947 | 112·059 |
| 199 | 112·172 | 112·285 | 112·398 | 112·511 | 112·624 | 112·737 | 112·850 | 112·963 | 113·076 | 113·189 |
| 200 | 113·302 | 113·416 | 113·529 | 113·642 | 113·756 | 113·870 | 113·983 | 114·097 | 114·211 | 114·324 |

## TABLE of the AREAS of CIRCLES in IMPERIAL GALLONS.

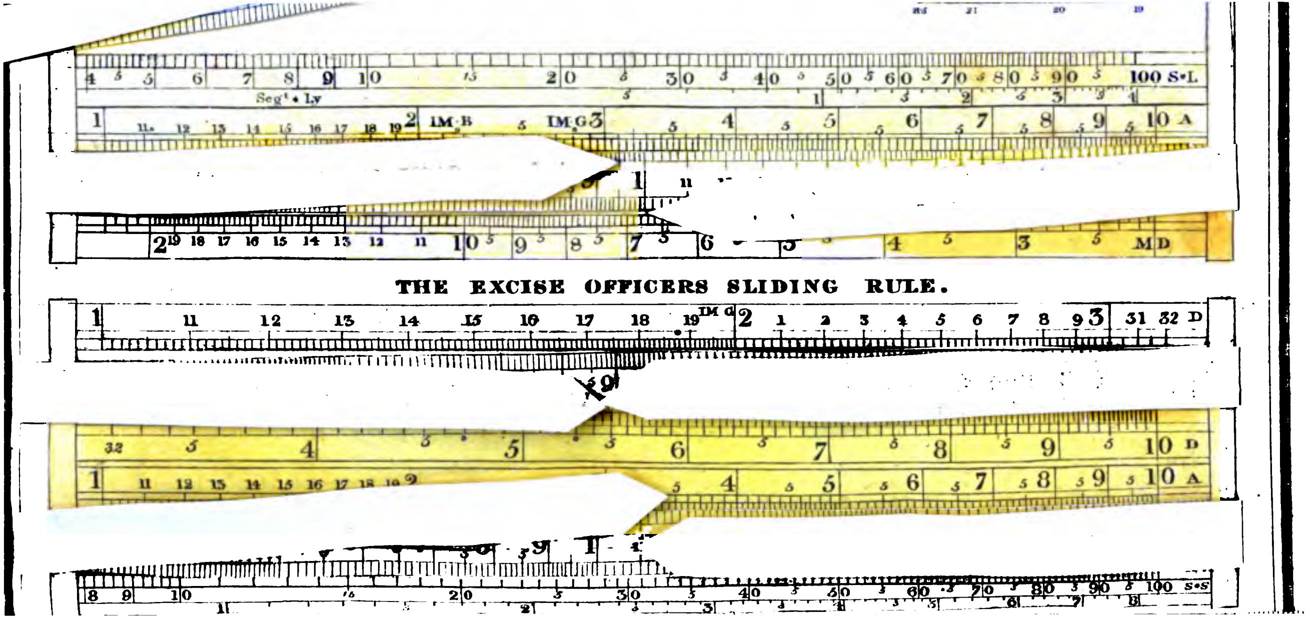
(Continued.)

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 201 | 114·438 | 114·552 | 114·666 | 114·780 | 114·894 | 115·008 | 115·122 | 115·237 | 115·351 | 115·465 |
| 202 | 115·580 | 115·694 | 115·809 | 115·923 | 116·038 | 116·153 | 116·267 | 116·382 | 116·497 | 116·612 |
| 203 | 116·727 | 116·842 | 116·957 | 117·072 | 117·187 | 117·303 | 117·418 | 117·533 | 117·649 | 117·764 |
| 204 | 117·880 | 117·995 | 118·111 | 118·227 | 118·342 | 118·458 | 118·574 | 118·690 | 118·806 | 118·922 |
| 205 | 119·038 | 119·154 | 119·271 | 119·387 | 119·503 | 119·620 | 119·736 | 119·853 | 119·969 | 120·086 |
| 206 | 120·202 | 120·319 | 120·436 | 120·553 | 120·670 | 120·787 | 120·904 | 121·021 | 121·138 | 121·255 |
| 207 | 121·372 | 121·490 | 121·607 | 121·724 | 121·842 | 121·959 | 122·077 | 122·195 | 122·312 | 122·430 |
| 208 | 122·548 | 122·666 | 122·784 | 122·902 | 123·020 | 123·138 | 123·256 | 123·374 | 123·492 | 123·611 |
| 209 | 123·729 | 123·847 | 123·966 | 124·084 | 124·203 | 124·322 | 124·440 | 124·559 | 124·678 | 124·797 |
| 210 | 124·916 | 125·035 | 125·154 | 125·273 | 125·392 | 125·511 | 125·631 | 125·750 | 125·869 | 125·989 |
| 211 | 126·108 | 126·228 | 126·348 | 126·467 | 126·587 | 126·707 | 126·827 | 126·947 | 127·066 | 127·186 |
| 212 | 127·307 | 127·427 | 127·547 | 127·667 | 127·787 | 127·908 | 128·028 | 128·149 | 128·269 | 128·390 |
| 213 | 128·510 | 128·631 | 128·752 | 128·873 | 128·994 | 129·114 | 129·235 | 129·356 | 129·478 | 129·599 |
| 214 | 129·720 | 129·841 | 129·962 | 130·084 | 130·205 | 130·327 | 130·448 | 130·570 | 130·692 | 130·813 |
| 215 | 130·935 | 131·057 | 131·179 | 131·301 | 131·423 | 131·545 | 131·667 | 131·789 | 131·911 | 132·034 |
| 216 | 132·156 | 132·278 | 132·401 | 132·523 | 132·646 | 132·768 | 132·891 | 133·014 | 133·137 | 133·260 |
| 217 | 133·382 | 133·505 | 133·628 | 133·751 | 133·875 | 133·998 | 134·121 | 134·244 | 134·368 | 134·491 |
| 218 | 134·615 | 134·738 | 134·862 | 134·985 | 135·109 | 135·233 | 135·357 | 135·480 | 135·604 | 135·728 |
| 219 | 135·852 | 135·977 | 136·101 | 136·225 | 136·349 | 136·473 | 136·598 | 136·722 | 136·847 | 136·971 |
| 220 | 137·096 | 137·221 | 137·345 | 137·470 | 137·595 | 137·720 | 137·845 | 137·970 | 138·095 | 138·220 |
| 221 | 138·345 | 138·470 | 138·596 | 138·721 | 138·846 | 138·972 | 139·097 | 139·223 | 139·348 | 139·474 |
| 222 | 139·600 | 139·726 | 139·852 | 139·977 | 140·103 | 140·229 | 140·356 | 140·482 | 140·608 | 140·734 |
| 223 | 140·860 | 140·987 | 141·113 | 141·240 | 141·366 | 141.493 | 141·619 | 141·746 | 141·873 | 142·000 |
| 224 | 142·127 | 142·253 | 142·380 | 142·508 | 142·635 | 142·762 | 142·889 | 143·016 | 143·144 | 143·271 |
| 225 | 143·398 | 143·526 | 143·653 | 143·781 | 143·909 | 144·036 | 144·164 | 144·292 | 144·420 | 144·548 |
| 226 | 144·676 | 144·804 | 144·932 | 145·060 | 145·188 | 145·317 | 145·445 | 145·573 | 145·702 | 145·830 |
| 227 | 145·959 | 146·088 | 146·216 | 146·345 | 146·474 | 146·603 | 146·732 | 146·861 | 146·990 | 147·119 |
| 228 | 147·248 | 147·377 | 147·506 | 147·636 | 147·765 | 147·894 | 148·024 | 148·153 | 148·283 | 148·413 |
| 229 | 148·542 | 148·672 | 148·802 | 148·932 | 149·062 | 149·192 | 149·322 | 149·452 | 149·582 | 149·712 |
| 230 | 149·842 | 149·973 | 150·103 | 150·234 | 150·364 | 150·495 | 150·625 | 150·756 | 150·887 | 151·017 |
| 231 | 151·148 | 151·279 | 151·410 | 151·541 | 151·672 | 151·803 | 151·935 | 152·066 | 152·197 | 152·328 |
| 232 | 152·460 | 152·591 | 152·723 | 152·854 | 152·986 | 153·118 | 153·249 | 153·381 | 153·513 | 153·645 |
| 233 | 153·777 | 153·909 | 154·041 | 154·173 | 154·305 | 154·438 | 154·570 | 154·702 | 154·835 | 154·967 |
| 234 | 155·100 | 155·232 | 155·365 | 155·498 | 155·630 | 155·763 | 155·896 | 156·029 | 156·162 | 156·295 |
| 235 | 156·428 | 156·561 | 156·695 | 156·828 | 156·961 | 157·095 | 157·228 | 157·362 | 157·495 | 157·629 |
| 236 | 157·762 | 157·896 | 158·030 | 158·164 | 158·298 | 158·432 | 158·566 | 158·700 | 158·834 | 158·968 |
| 237 | 159·102 | 159·236 | 159·371 | 159·505 | 159·640 | 159·774 | 159·909 | 160·043 | 160·178 | 160·313 |
| 238 | 160·448 | 160·582 | 160·717 | 160·852 | 160·987 | 161·122 | 161·258 | 161·393 | 161·528 | 161·663 |
| 239 | 161·799 | 161·934 | 162·070 | 162·205 | 162·341 | 162·476 | 162·612 | 162·748 | 162·884 | 163·020 |
| 240 | 163·156 | 163·292 | 163·428 | 163·564 | 163·700 | 163·836 | 163·972 | 164·109 | 164·245 | 164·382 |
| 241 | 164·518 | 164·655 | 164·791 | 164·928 | 165·065 | 165·201 | 165·338 | 165·475 | 165·612 | 165·749 |
| 242 | 165·886 | 166·023 | 166·160 | 166·298 | 166·435 | 166·572 | 166·710 | 166·847 | 166·985 | 167·122 |
| 243 | 167·260 | 167·398 | 167·535 | 167·673 | 167·811 | 167·949 | 168·087 | 168·225 | 168·363 | 168·501 |
| 244 | 168·639 | 168·778 | 168·916 | 169·054 | 169·193 | 169·331 | 169·470 | 169·608 | 169·747 | 169·886 |
| 245 | 170·025 | 170·163 | 170·302 | 170·441 | 170·580 | 170·719 | 170·858 | 170·998 | 171·137 | 171·276 |
| 246 | 171·415 | 171·555 | 171·694 | 171·834 | 171·973 | 172·113 | 172·253 | 172·392 | 172·532 | 172·672 |
| 247 | 172·812 | 172·952 | 173·092 | 173·232 | 173·372 | 173·512 | 173·652 | 173·793 | 173·933 | 174·073 |
| 248 | 174·214 | 174·354 | 174·495 | 174·636 | 174·776 | 174·917 | 175·058 | 175·199 | 175·340 | 175·481 |
| 249 | 175·622 | 175·763 | 175·904 | 176·045 | 176·186 | 176·328 | 176·469 | 176·611 | 176·752 | 176·894 |
| 250 | 177·035 | 177·177 | 177·319 | 177·460 | 177·602 | 177·744 | 177·886 | 178·028 | 178·170 | 178·312 |

## TABLE *of the* AREAS *of* CIRCLES *in* IMPERIAL GALLONS.

*(Continued.)*

| Diameters in Inches. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 251 | 178·454 | 178·596 | 178·739 | 178·881 | 179·024 | 179·166 | 179·308 | 179·451 | 179·594 | 179·736 |
| 252 | 179·879 | 180·022 | 180·165 | 180·308 | 180·451 | 180·594 | 180·737 | 180·880 | 181·023 | 181·166 |
| 253 | 181·310 | 181·453 | 181·596 | 181·740 | 181·883 | 182·027 | 182·170 | 182·314 | 182·458 | 182·602 |
| 254 | 182·746 | 182·890 | 183·034 | 183·178 | 183·322 | 183·466 | 183·610 | 183·754 | 183·899 | 184·043 |
| 255 | 184·187 | 184·332 | 184·476 | 184·621 | 184·766 | 184·910 | 185·055 | 185·200 | 185·345 | 185·490 |
| 256 | 185·635 | 185·780 | 185·925 | 186·070 | 186·215 | 186·361 | 186·506 | 186·651 | 186·797 | 186·942 |
| 257 | 187·088 | 187·234 | 187·379 | 187·525 | 187·671 | 187·817 | 187·963 | 188·108 | 188·255 | 188·401 |
| 258 | 188·547 | 188·693 | 188·839 | 188·985 | 189·132 | 189·278 | 189·425 | 189·571 | 189·718 | 189·864 |
| 259 | 190·011 | 190·158 | 190·305 | 190·452 | 190·599 | 190·746 | 190·893 | 191·040 | 191·187 | 191·334 |
| 260 | 191·481 | 191·629 | 191·776 | 191·923 | 192·071 | 192·218 | 192·366 | 192·514 | 192·661 | 192·809 |
| 261 | 192·957 | 193·105 | 193·253 | 193·401 | 193·549 | 193·697 | 193·845 | 193·993 | 194·142 | 194·290 |
| 262 | 194·438 | 194·587 | 194·735 | 194·884 | 195·033 | 195·181 | 195·330 | 195·479 | 195·628 | 195·777 |
| 263 | 195·926 | 196·075 | 196·224 | 196·373 | 196·522 | 196·671 | 196·821 | 196·970 | 197·119 | 197·269 |
| 264 | 197·418 | 197·568 | 197·718 | 197·867 | 198·017 | 198·167 | 198·317 | 198·467 | 198·617 | 198·767 |
| 265 | 198·917 | 199·067 | 199·217 | 199·367 | 199·518 | 199·668 | 199·819 | 199·969 | 200·120 | 200·270 |
| 266 | 200·421 | 200·572 | 200·722 | 200·873 | 201·024 | 201·175 | 201·326 | 201·477 | 201·628 | 201·779 |
| 267 | 201·931 | 202·082 | 202·233 | 202·385 | 202·536 | 202·688 | 202·839 | 202·991 | 203·143 | 203·294 |
| 268 | 203·446 | 203·598 | 203·750 | 203·902 | 204·054 | 204·206 | 204·358 | 204·510 | 204·662 | 204·815 |
| 269 | 204·967 | 205·120 | 205·272 | 205·425 | 205·577 | 205·730 | 205·883 | 206·035 | 206·188 | 206·341 |
| 270 | 206·494 | 206·647 | 206·800 | 206·953 | 207·106 | 207·259 | 207·413 | 207·566 | 207·719 | 207·873 |
| 271 | 208·026 | 208·180 | 208·333 | 208·487 | 208·641 | 208·795 | 208·948 | 209·102 | 209·256 | 209·410 |
| 272 | 209·564 | 209·719 | 209·873 | 210·027 | 210·181 | 210·336 | 210·490 | 210·644 | 210·799 | 210·954 |
| 273 | 211·108 | 211·263 | 211·418 | 211·572 | 211·727 | 211·882 | 212·037 | 212·192 | 212·347 | 212·502 |
| 274 | 212·658 | 212·813 | 212·968 | 213·123 | 213·279 | 213·434 | 213·590 | 213·746 | 213·901 | 214·057 |
| 275 | 214·213 | 214·368 | 214·524 | 214·680 | 214·836 | 214·992 | 215·148 | 215·305 | 215·461 | 215·617 |
| 276 | 215·773 | 215·930 | 216·086 | 216·243 | 216·399 | 216·556 | 216·713 | 216·869 | 217·026 | 217·183 |
| 277 | 217·340 | 217·497 | 217·654 | 217·811 | 217·968 | 218·125 | 218·282 | 218·440 | 218·597 | 218·754 |
| 278 | 218·912 | 219·069 | 219·227 | 219·385 | 219·542 | 219·700 | 219·858 | 220·016 | 220·174 | 220·332 |
| 279 | 220·490 | 220·648 | 220·806 | 220·964 | 221·122 | 221·281 | 221·439 | 221·597 | 221·756 | 221·914 |
| 280 | 222·073 | 222·232 | 222·390 | 222·549 | 222·708 | 222·867 | 223·026 | 223·185 | 223·344 | 223·503 |
| 281 | 223·662 | 223·821 | 223·981 | 224·140 | 224·299 | 224·459 | 224·618 | 224·778 | 224·937 | 225·097 |
| 282 | 225·257 | 225·417 | 225·576 | 225·736 | 225·896 | 226·056 | 226·216 | 226·377 | 226·537 | 226·697 |
| 283 | 226·857 | 227·018 | 227·178 | 227·338 | 227·499 | 227·660 | 227·820 | 227·981 | 228·142 | 228·302 |
| 284 | 228·463 | 228·624 | 228·785 | 228·946 | 229·107 | 229·268 | 229·430 | 229·591 | 229·752 | 229·914 |
| 285 | 230·075 | 230·237 | 230·398 | 230·560 | 230·721 | 230·883 | 231·045 | 231·207 | 231·369 | 231·530 |
| 286 | 231·692 | 231·854 | 232·017 | 232·179 | 232·341 | 232·503 | 232·666 | 232·828 | 232·990 | 233·153 |
| 287 | 233·316 | 233·478 | 233·641 | 233·804 | 233·966 | 234·129 | 234·292 | 234·455 | 234·618 | 234·781 |
| 288 | 234·944 | 235·107 | 235·271 | 235·434 | 235·597 | 235·761 | 235·924 | 236·088 | 236·251 | 236·415 |
| 289 | 236·579 | 236·742 | 236·906 | 237·070 | 237·234 | 237·398 | 237·562 | 237·726 | 237·890 | 238·054 |
| 290 | 238·219 | 238·383 | 238·547 | 238·712 | 238·876 | 239·041 | 239·205 | 239·370 | 239·535 | 239·700 |
| 291 | 239·864 | 240·029 | 240·194 | 240·359 | 240·524 | 240·689 | 240·855 | 241·020 | 241·185 | 241·350 |
| 292 | 241·516 | 241·681 | 241·847 | 242·012 | 242·178 | 242·344 | 242·509 | 242·675 | 242·841 | 243·007 |
| 293 | 243·173 | 243·339 | 243·505 | 243·671 | 243·837 | 244·003 | 244·170 | 244·336 | 244·503 | 244·669 |
| 294 | 244·836 | 245·002 | 245·169 | 245·335 | 245·502 | 245·669 | 245·836 | 246·003 | 246·170 | 246·337 |
| 295 | 246·504 | 246·671 | 246·838 | 247·006 | 247·173 | 247·340 | 247·508 | 247·675 | 247·843 | 248·010 |
| 296 | 248·178 | 248·346 | 248·513 | 248·681 | 248·849 | 249·017 | 249·185 | 249·353 | 249·521 | 249·689 |
| 297 | 249·858 | 250·026 | 250·194 | 250·363 | 250·531 | 250·700 | 250·868 | 251·037 | 251·206 | 251·374 |
| 298 | 251·543 | 251·712 | 251·881 | 252·050 | 252·219 | 252·388 | 252·557 | 252·726 | 252·895 | 253·065 |
| 299 | 253·234 | 253·404 | 253·573 | 253·743 | 253·912 | 254·082 | 254·251 | 254·421 | 254·591 | 254·761 |
| 300 | 254·931 | 255·101 | 255·271 | 255·441 | 255·611 | 255·781 | 255·952 | 256·122 | 256·292 | 256·463 |



THE EXCISE OFFICERS SLIDING RULE.

# CHAPTER III.

# GAUGING.

GAUGING, from the French word *jauge*, a "measuring-rod," r "standard," is the art of finding the contents of casks nd vessels used by persons under the survey of the excise officers, and of fixing and tabulating the same in such manner, that the contents thereof when full, or partly full, may be ascertained by a measuring-rod, or some concise method of computation. The term "Gauger" is sometimes used to express the whole business of an excise officer.

Many of the calculations in gauging are performed by the sliding-rule, the construction and use of which, therefore, it will be proper to describe; after which the practice of gauging, as at present performed by the officers of excise, may be considered under the following heads:—1. Gauging open Vessels. And 2. Cask Gauging and Ullaging.

## PART I.—THE SLIDING-RULE.

THE sliding-rule is a portable instrument for facilitating mathematical calculations, by the sliding of the different parts of the instrument one by another; the lines and divisions upon the respective parts giving the answers by inspection. It is, as to its principal lines or tables, founded upon the principle of logarithms.

The sliding-rules used in gauging are made in different forms and of different lengths, from six to twenty-four inches; but nine and twelve inches are the most common lengths. The one from which the annexed engraving is taken, is only six inches long, and has been adopted for the convenience of its size. In whatever form the instrument is made, it has always four lines or parts, known by the names, and marked with the letters, "A," "B," "C," and "D," and different marks called *gauge-points*, varying with the particular business of the person using the rule; and all sliding-rules adapted to malt-gauging have a line marked "M D;" while those used for ullaging casks have two lines, marked respectively "S S," and "S L;" and sometimes there are three other lines marked "X," "Sphd.," and "2 Var."

On some sliding-rules there are lines for reducing and valuing spirits; and on others, of a larger size, there is sometimes a line of inches and tenths, and a line called a diagonal-line; but these lines are more commonly graduated on separate rules, called proof-rules, and diagonal-rods.

### 1. *Of the Lines* A *and* B.

The line A is called *Gunter's line*, from its inventor, Mr. Edward Gunter, who, in the year 1624, first made the discovery of applying logarithms* to extension; and of

---

* *Logarithms* are numbers in arithmetical progression, corresponding with other numbers in geometrical progression; thus:—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 |

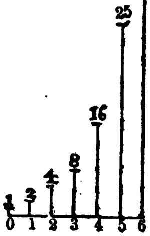
Here the first series of numbers, or indices, in the arithmetical progression are the *logarithms* of the second series, which is geometrical; because it will be found that if any two of the indices be added together, their *sum* will be the logarithm of the *product* of the numbers to which they belong; and if any one of the indices be *subtracted* from another, their difference is the index of the *quotient* of the numbers. Thus, 2 and 3 are 5; the number against 5 is 32; which is the *product* of 4 × 8, whose logarithms are 2 and 3; and so 5 from 7 leaves 2—the logarithm corresponding to 4, the quotient of 128 by 32. Hence, it appears that *addition* of logarithms answers to *multiplication* of common numbers; and *subtraction*, to *division*.

The same would be the case with any other geometrical series. And performing upon this line, by means of a pair of compasses, the business of multiplication, division, and various arithmetical operations where the rule of proportion was required. This line, which, from its utility, is sometimes also called the "line of lines," and the "line of numbers," contains a scale or radius of graduated logarithms, numbered from the left to the right, with the figures 1 2 3 4 5 6 7 8 9 10, and the spaces between each of these integers are again graduated into sub-divisions more or less minute, according to the length of the space.

When this line takes up the whole extent of the fixed part of the rule, and the numbers run in regular progression, it is (in whatever part it may be placed) marked with the letter "A."

---

since numbers are but expressions for the measure of distances from a fixed point, it follows, that if from the commencement of any line, as 0, we set off equal distances in the points 1, 2, 3, &c., and raise against them a series of perpendiculars 1, 2, 4, 8, &c., increasing in length in proportion as their distances from 0, we shall have, in the extremities of these perpendiculars, a series of distances, 1, 2, 4, 8, &c., whose logarithms will be the distances, 0, 1, 2, 3, &c. These, representing the indices of the distances measured by the perpendiculars, will, of course, possess the same properties as the indices themselves; and by the application of the compasses from one part of the indices to the other, we attain the same results as if we operated by arithmetical calculation. Thus, if it be required to multiply 16 by 4; with a pair of compasses take the distance from 0 to 2—the index corresponding to 4; set one foot of the compasses on 4—the index of 16—the other point will reach forwards to 6—the index of 64, the product of the numbers 4 and 16. It is, however, evident that, as far as the solution of questions is concerned, the perpendiculars are of no importance, the *equal* distances and the *increasing* numbers being all that are required. If, then, we affix the progressive numbers, or logarithms, answering to the indices at the places where, in a scale of equal parts, the indices themselves would be placed; such logarithms may be applied to the usual purposes to which logarithms are adapted.—*Kentish's Treatise*, &c.



In modern sliding-rules there are usually two or more of these lines exactly alike, which affords the facility of working two questions, or double proportion, at the same time. In the annexed engraving there are three such lines. On some rules there is a double radius, marked with the same letter, but the modern rules have only a single radius, as in the engraving.

The line B is on a moveable slider, which is made to run in a groove, within or under the line A. It contains the same scale (Gunter's line of logarithms) as the line A, and has always a counterpart, also marked with the letter "B," which being taken out of the groove in which it usually rests, and put into the same groove with its counterpart, the two brass ends of both being made to fit together,

---

Such was the invention of Mr. Gunter; but the use of compasses being found both troublesome and liable to error, Mr. Thomas Everard, formerly an officer, and afterwards a collector of excise, in the year 1683, made a very considerable improvement in the application of the line of numbers, by contriving one line to slide by another in the same manner as the instrument we are now speaking of, and which, on that account, is sometimes called Everard's sliding-rule.—*Moss's and Leadbetter's Gauging.*

In the original sliding-rule the line A contained a double radius, but Mr. Vero, some time a collector of excise, made an alteration in it, so that the whole length of the rule had but one radius, while two of the sliders were made to fit in and work together as a double radius.—*Leadbetter's Gauger.* Several other alterations have been subsequently made in the sliding-rule, but the principles upon which such alterations have proceeded are the same as the original invention.

*To construct the line of numbers.*—Let a diagonal-line or rule, (equal to the whole distance of the intended radius,) upon which the line of numbers is to be graduated, be divided into one thousand equal parts; then, with a pair of compasses, take from this line of equal parts the numbers expressing the logarithms (to the first three places of decimals, omitting the characteristic) of 101, 102, 103, 104, &c., progressively to 1000, and apply them successively from 1, (the beginning of the radius,) and we shall thereby make out all the divisions on the radius.

But the most expeditious and exact method of forming a line of numbers is as follows:—Open the sector until the distance of the two brass pins on the line of lines (marked "L L") be equal to the length of the intended radius; place 1 (the logarithm of which is 0) at the beginning of the left hand; then as the space between 1 and 2 is to be divided into fifty parts, take from the sector (opened to the intended radius) the distances they become a double radius, numbered from the left to the right. By moving this double radius in the groove, until it is properly adjusted, problems which formerly required the use of the compasses are solved by inspection.

In the engraving, all the sliders have double radii, which was necessary in order to show the method of working; but in the instrument itself, the sliders are only of the same length as the rule, for the convenience of the pocket.

On each of the lines A and B, there are brass pins or marks against the divisors for squares and circles, (see pages 32 and 57,) for facilitating the operations when the answer is required in gallons or bushels, &c.

---

or numbers answering to (at least the three first places of decimals) the logarithms of 1·02, 1·04, 1·06, 1·08, &c., to 2; then those distances being successively applied from 1 along the line, will mark out all the divisions between 1 and 2. For the next division between 2 and 3, which is divided into twenty parts, take from the sector the logarithms of 2·05, 2·1, 2·15, 2·2, 2·25, which apply successively along the line to 3. By proceeding in this manner, the divisions between 3, 4, 5, 6, 7, 8, 9, and 10, may be easily marked out.—*Moss's Gauging.*

The following table, extracted from a table of logarithms, (the indices and three last figures being omitted,) includes all the numbers which it will be necessary to take from the scale of equal parts for graduating the common sliding-rule, however minutely it be divided.

| No. | Log. | No. | Log. | No. | Log. | No. | Log. | No. | Log. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 00 | 21 | 322 | 41 | 612 | 61 | 785 | 81 | 908 |
| 2 | 30 | 22 | 342 | 42 | 623 | 62 | 792 | 82 | 914 |
| 3 | 47 | 23 | 362 | 43 | 633 | 63 | 799 | 83 | 919 |
| 4 | 60 | 24 | 380 | 44 | 643 | 64 | 806 | 84 | 924 |
| 5 | 70 | 25 | 398 | 45 | 653 | 65 | 813 | 85 | 929 |
| 6 | 78 | 26 | 415 | 46 | 663 | 66 | 819 | 86 | 934 |
| 7 | 84 | 27 | 431 | 47 | 672 | 67 | 826 | 87 | 939 |
| 8 | 90 | 28 | 447 | 48 | 681 | 68 | 832 | 88 | 944 |
| 9 | 95 | 29 | 462 | 49 | 690 | 69 | 839 | 89 | 949 |
| 10 | 000 | 30 | 477 | 50 | 700 | 70 | 845 | 90 | 954 |
| 11 | 041 | 31 | 491 | 51 | 707 | 71 | 851 | 91 | 959 |
| 12 | 079 | 32 | 505 | 52 | 716 | 72 | 857 | 92 | 964 |
| 13 | 114 | 33 | 518 | 53 | 724 | 73 | 863 | 93 | 968 |
| 14 | 146 | 34 | 531 | 54 | 732 | 74 | 869 | 94 | 973 |
| 15 | 176 | 35 | 544 | 55 | 740 | 75 | 875 | 95 | 978 |
| 16 | 204 | 36 | 556 | 56 | 748 | 76 | 881 | 96 | 982 |
| 17 | 230 | 37 | 568 | 57 | 756 | 77 | 886 | 97 | 987 |
| 18 | 255 | 38 | 580 | 58 | 763 | 78 | 892 | 98 | 991 |
| 19 | 279 | 39 | 591 | 59 | 771 | 79 | 898 | 99 | 996 |
| 20 | 301 | 40 | 602 | 60 | 778 | 80 | 903 | 100 | 0000 |

To estimate the value of the numbers.—The numbers on Gunter's line have no determinate value of their own, but depend upon the value that is set upon the unit at the left hand of the line, which may either be considered as 1, 10, 100, 1000, &c. If this first figure be called 1, the following integral numbers will be 2, 3, &c.; and should there be a second radius, the first integer will be 10, and the integral figures which follow will be 20, 30, &c., and the 10 at the right hand end will be 100. If the first or left hand unit be considered 10, the 2 will be 20, the 3, 30, &c., and the first unit on the second radius will be 100, and the following figures will be 200, 300, 400, &c., and the 10 at the right hand will be 1000. And if the first or left hand unit be called 100, the first unit on the second radius will be 1000, and the following figures 2000, 3000, 4000, &c., and the 10 at the right hand, 10,000.

The values of the integral divisions being thus estimated, those of the intermediate divisions may be easily known.*

---

* From 1 to 2 the tenths are usually divided into five parts, each part containing two hundredths; therefore,

| If the figure 1 at the beginning of the line represents | then the larger divisions will represent | and the smaller divisions |
|---|---|---|
| ·1 | ·01 | ·002 |
| 1 | ·1 | ·02 |
| 10 | 1 | ·2 |
| 100 | 10 | 2 |

From 2 to 5 the tenths are divided into two parts, each part containing five hundredths; therefore,

| If the figure 2 represents | then the larger divisions will represent | and the smaller divisions |
|---|---|---|
| ·2 | ·01 | ·005 |
| 2 | ·1 | ·05 |
| 20 | 1 | ·5 |
| 200 | 10 | 5 |

From 5 to 10 the tenths are not divided; the hundredths, therefore, must be guessed at. And

| If the figure 5 represents | the tenths will represent |
|---|---|
| ·05 | ·01 |
| ·5 | ·1 |
| 5 | 1 |
| 50 | 10 |

The integral numbers, or principal divisions, in the second radius being ten times the value of those in the first, its sub-division will be in the same proportion, or ten times the value of the sub-divisions of the former.

To FIND THE PRODUCT OF TWO GIVEN NUMBERS.—Set 1 on B to either of the numbers on A, then against the other number on B is the required product on A.[*]

To FIND THE QUOTIENT OF TWO GIVEN NUMBERS.—Set 1 on B to the divisor on A, then against the dividend on A is the quotient on B.[†]

---

[*] EXAMPLES IN MULTIPLICATION.

(1.) Required the product of 3 × 8.

Set 1 on B opposite 3 on A, then against 8 on B will be found 24 on A. Or set 1 on B opposite 8 on A; then against 3 on B will be found 24 on A.

If, when 1 on B is set to either of the factors on A, the other factor cannot be expressed on B according to the true numeration of the rule, or being found, it falls beyond the line A, the second factor may be divided by 10, 100, or 1000, until the quotient can be found opposite to some division (or product) on A; and after the product has been obtained, it must be multiplied by the same power as the given factor was divided by, for the proper answer.

(2.) Find the product of 120 by 95.

Set 1 on B to 120 on A, (taking the unit at A as 100,) and looking opposite one-tenth of 95, namely, 9·5, on B, we have 1140 on A, which, being multiplied by 10, gives 11400, the product required.

When the product consists of more than three or four figures, it is difficult to value the figures on the rule; but it will be easy to bear one or two of them in memory. Thus, if it were required to multiply 56 by 38, the product will be 2128; for the last figure is known to be an 8 by multiplying 6 by 8 mentally; and it is evident, from the rule, that the product is more than 2118, and less than 2138.—*Nisbet and Little's Gauging.*

When there are two or more modes of performing the same operation, either in multiplication or in any other calculation, and two or more numbers are given or required which can be *exactly* expressed on the sliding-rule, while there is another number which can only be *estimated*; that mode of operation should be adopted which will place an *exact* value opposite an *estimated* one, and *vice versa.*—*Woollgar.*

[†] EXAMPLES IN DIVISION.

(3.) Divide 75 by 5.

Set 1 on B to 5 on A, then against 75 on A is the quotient, 15, on B.

If the dividend cannot be properly expressed on B, it may be divided by some power of 10, so as to bring it within the rule; and the quotient, when found, multiplied by the same power. (See Multiplication, *supra.*)

(4.) What is the quotent of 385 divided by 7?

To 7 on A set 1 on B, and opposite 38·5 (the tenth of 385) on A, are 5·5 on B, which, being multiplied by 10, gives 55, the quotient sought.

A vulgar fraction may be reduced to a decimal by this rule, the denominator being considered as the divisor, and the numerator as the dividend.

TO PERFORM THE RULE OF THREE.—As the first term upon A is to the second term upon B, so is the third term upon A to the fourth term upon B.*

TO FIND THE AREAS OF SQUARES, CIRCLES, &c.—As the proper square or circular divisor on A is to a side, or diameter, on B, so is the (other) side, or diameter, on A to the area on B, in terms of the divisor employed.†

---

* EXAMPLES IN THE RULE OF THREE.

(5.) If three bushels of malt cost 12*s*., what will nine bushels cost at the same rate? (See page 10.)

Set 3 upon A against 12 upon B, then against 9 upon A we find on B 36, the number of shillings that nine bushels will cost.

The same result will be obtained if the lines be transposed, thus,

| | On B | | on A | | on B | | on A. |
|---|---|---|---|---|---|---|---|
| As | 3 | : | 12 | :: | 9 | :: | 36 |

(6.) What is a fourth proportional to the numbers 12, 24, 36? Ans. 72.

The method of finding a third proportional is exactly the same, the second number being repeated twice. Thus, if a third proportional be required to 80 and 60, it will be—as 80 on A : 60 on B :: 60 on A : 45 on B.

Factors for bushels, &c., may be found by the Rule of Three on the sliding-rule, as follows:—

| On A | | on B | | on A | | on B. |
|---|---|---|---|---|---|---|
| As the divisor | is to | 1, | so is | 1 | to the factor required. | |

By this rule, also, spirit-stocks may be taken and the charges estimated, and spirits may be reduced, averaged, &c., as shewn (by the pen) in page 41, &c., thus,

(7.) Reduce forty gallons of spirits at 30 per cent. over proof, and at 30 per cent. under proof, respectively, to proof.

| On A | | on B | | on A | | on B. |
|---|---|---|---|---|---|---|
| As 100 (proof) | : | 40 (quantity) | :: | 130· (proposed | : | 52· (gallons at |
| | | | | 70 strength) | : | 28 proof.) |

(8.) Reduce seventy gallons at proof to 30 per cent. over proof, and also to 30 per cent. under proof.

| On A | | on B | | on A | on B. |
|---|---|---|---|---|---|
| As 130 (strength | : | 70 (quantity) | :: | 100 (given | 53·8 galls. 30 o. p. |
| As 70 required) | | 70 | | 100 strength) | 100 galls. 30 u. p. |

† EXAMPLES OF THE AREAS OF SUPERFICIES.

(9.) What is the area, in gallons and bushels, of a square, the side being 40 inches?

| On A | | on B | | on A | | on B. |
|---|---|---|---|---|---|---|
| As 277·274 (marked G) | : | 40 | :: | 40 | : | 5·77 Area in gallons. |
| As 2218·192 (marked MB) | : | 40 | :: | 40 | : | ·72 Area in bushels. |

## 2. *Of the Lines* C *and* D.

The line D is also a Gunter's line, constructed in the same manner as the lines A and B, only it has double the power;* the distance between 1 and 10 being twice as long, and the other divisions in proportion. On the excise officers' sliding-rule this line is usually divided into two; one half being above the slider, and numbered from left to right, with the figures 1, 11, 12, 13, 14, 15, 16, 17, 18, 19. 2, 1, 2, 3, 4, 5, 6, 7, 8, 9. 3, 31, 32; and the other half continued under the slider, namely—32, 4, 5, 6, 7, 8, 9, 10; at which point it terminates opposite 3·162, (the square-root of 10,) on the upper part.

---

(10.) What is the area in gallons of a circle, the diameter of which is 21·5 inches? (See page 120.)

| | On A | | on B | | on A | | on B. | |
|---|---|---|---|---|---|---|---|---|
| As | 353 | : | 21·5 | :: | 21·5 | : | 1·309 | Area in gallons. |

(11.) What is the area in bushels of malt, and in pounds-weight of hot hard soap of a rectangular figure, the length being 45 inches, and the breadth 15 inches?

| | On A | | on B | | on A | | on B. | |
|---|---|---|---|---|---|---|---|---|
| As | 2218·192 | : | 45 | :: | 15 | : | ·304 | Area in bushels. |
| As | 28 | : | 45 | :: | 15 | : | 24·10 | Area in lbs. weight. |

The area of an ellipsis may be found by the same rule; and by a double operation the contents of rectangular solids, cylinders, &c., may be obtained. Thus:—Find the area of the base as above directed, then say, as 1 on A is to the area on B, so is the depth on A to the content on B. But questions of this kind can be better performed by the gauge-points on the lines C and D. (See also the line M D, *infra.*)

* Another of the principles of a logarithmic series (see page 162) is, that if any one of the indices be *multiplied* by another, denoting any *power* or multiple of the other, the product will be the index of that *power*; and if the index of any number be *divided* by the index of any *root*, the quotient will be the index of that *root*. Thus, to find the *square* of 8; its index is 3, which doubled becomes 6, the index of 64, the square of 8, as required. And so, to find the *square-root* of 16; its index is 4, the half of which, 2, is the index of 4, the square-root of 16, as required. Whence it follows, that the multiplication of logarithms answers to the involution of common numbers, and division to evolution. This will appear if, from the logarithmic line in page 163, we take half the distance from 0 to the index of any given number, (say 6, the index of 64,) we shall find that such half-distance reaches to the index (3) of 8, the square-root of such given numbe

Operations on this line are performed by means of two sliders, marked "C," which are exactly the same as those marked "B," and are differently named only for the sake of distinction. The line B may, indeed, be used instead of the line C, when the former is found more convenient.

TO ESTIMATE THE VALUE OF THE NUMBERS.—The value of the numbers on the lines C and D, are estimated in the same manner as those on the lines A and B; but as the sub-divisions on D are more minute than those on A, B, and C, there being more room on the line for graduating them, they must be estimated accordingly.

TO SQUARE ANY GIVEN NUMBER.—Set 1 on C to 1 on D, then against the proposed number on D is its square on C.

TO EXTRACT THE SQUARE-ROOT.—Set 1 on C to 1 on D, then against any proposed number on C is its square-root on D.*

---

(8 being the square-root of 64); and this would appear still plainer if another line of logarithmic distances were laid down, on which the distances of the latter were twice the distances of the former.

If, then, instead of the perpendiculars, we affix on two scales the progressive numbers, or logarithms, answering to the indices at the respective places where the indices themselves would be placed, we have a table of squares and roots; and by making one of such squares moveable, we are enabled to work upon them questions which would otherwise require the tedious and difficult operation of involution. Such are the lines C and D, the line D being constructed in the same manner as the line C, with this difference only, that D has twice the *power* of C, and is more minutely graduated in its sub-divisions.

* When the lines C and D are thus set (1 to 1), the line C forms a series of squares of the line D, and the line D forms a series of square-roots of the line C. Thus, against 3 on D is 9 (its square) on C; and conversely, against 9 on C is 3 (its square-root) on D, &c. In estimating the numbers, it must be observed that if the 10 upon D be called 1, the 1 on C will be 10; if the 10 on D be called 10, the 1 on C will be called 100; if the 1 on D be called 100, the 1 on C will be 1000, &c. If the square contains an odd number of integers, the root will be found opposite on the first radius on C; but if the square consists of an even number of places, the root will fall against the second radius.

**TO FIND A MEAN-PROPORTIONAL BETWEEN TWO GIVEN NUMBERS, OR TO EXTRACT THE SQUARE-ROOT OF THE PRODUCT OF TWO GIVEN NUMBERS.**—Set one of the given numbers on C to the like number on D, then against the other given number on C is the mean-proportional on D.*

**TO FIND A NUMBER WHICH SHALL HAVE TO A GIVEN ONE THE SAME RATIO WHICH THE SQUARES OF TWO GIVEN NUMBERS HAVE TO ONE ANOTHER.**—Set the first term of the ratio on D to the given number on C, then opposite to the other term of the ratio on D stands the answer on C.†

**TO FIND A NUMBER WHICH SHALL BE TO A GIVEN ONE AS THE SQUARE-ROOTS OF TWO GIVEN NUMBERS.**—Set the first term on C to the given number on D, then against the other term on C stands the answer on D.‡

---

* EXAMPLES OF MEAN-PROPORTIONALS.

(1.) What are the mean-proportionals between 4 and 9; between 20 and 30; between 81 and 25, and between 3·4 and 12·9, respectively.

| | On C | | on D | | on C | | on D. |
|---|---|---|---|---|---|---|---|
| Set | 4<br>20<br>81<br>3·4 | to | 4<br>20<br>81<br>3·4 | then against | 9<br>30<br>25<br>12·9 | is the answer | 6<br>24·49<br>45<br>6·62 |

This rule is of extensive application in gauging, and ought to be well understood by the practical officer. (See page 19.)

† EXAMPLE OF PROPORTIONALS TO SQUARES.

(2.) Required the number which will be to 12 as the square of 9 is to that of 3.

| On D | | on C | | on D | | on C. |
|---|---|---|---|---|---|---|
| As 3 | : | 12 | :: | 9 | : | 108 Ans. |

‡ EXAMPLE OF PROPORTIONALS TO ROOTS.

(3.) To what number will 3 have the same ratio, with the square-root of 108 to that of 48?

| On D | | on C | | on C | | on D. |
|---|---|---|---|---|---|---|
| As 3 | : | 108 | : | 48 | : | 2 |

TO CUBE A GIVEN NUMBER.—Set 1 on D to the root or given number on C, then against the root on D is the cube on C.*

TO EXTRACT THE CUBE-ROOT OF A GIVEN NUMBER.—Move the slider either way, until 1 at the beginning of the line D, 10 at the end of the line D, and the given number on C, cut the same number on the opposite lines, and that number will be the root required.†

### 3. *Of Gauge-Points.*‡

GAUGE-POINTS, are the square-roots of divisors, adapted to particular operations, and known by certain marks or points upon the sliding-rule. Thus, on the line D, at the

---

* EXAMPLE OF A CUBE.

(4.) What is the cube of 4?

Set 1 on D to 4 on C; then against 4 on D is 64 on C.

† EXAMPLE OF THE CUBE-ROOT.

(5.) What is the cube-root of 8?

Find 8 on the line C, then move the slider until 1 on D, 8 on C, and 10 on D, cut the same number on the opposite line, which will be found to be 2, the cube-root required.

In "Leadbetter's Gauging," page 45, it is stated that the hint for this operation was given by Mr. Clarke Eades, of Petersfield.

If the sliding-rule contained a radius of treble power, such radius would be the cube of C, without moving the slider.

‡ Divisors and multipliers, when marked on the sliding-rule, are sometimes called gauge-points, but in works on gauging, the term is usually confined to square-roots.

It has been seen that if the roots of two given numbers are known, we can find a number by means of the lines C and D, which will be to another given number in the same ratio as the two roots are to each other. Hence, if we can ascertain the square-root of the area of a square or circle containing exactly one gallon, or one bushel, &c., and also the square-root of the area of a square or circle of any other determinate size, we can, by this means of working, find the proportion or number of gallons which the second square-root bears to the first; or, in other words, we can thus find the area or content of any square or circle which can be compared with a square or circle whose area is one gallon, one bushel, &c. Now, the side of every square is the square-root of its area (see page 80); hence, if we extract the square-root of 277·274, the number of inches in a gallon, we obtain the side of a square, or the square-root of a square, whose area number 47·10, is a brass pin, with the mark "M S," which is the square gauge-point for bushels, being, in fact, the square-root, or side of a square, whose area is exactly one bushel. At 53·14, on the same line, is another brass pin, with the mark "M R," which is the round or circular gauge-points for bushels. And at 18·79, on the same line, is another brass pin, with the mark "G," or "I M G,"

---

is exactly one gallon; and so, if we extract the square-root of 2218·192, the number of inches in a bushel, we obtain the side of a square, or the square-root of a square, whose area is exactly one bushel. Again, the diameter of every circle is the square-root of the circular divisor (see page 57); hence, if we extract the square-root of 353·036, (which is equal to 277·274 ÷ ·7854, (see page 91,) we obtain the diameter of a circle whose area is exactly one gallon; and so, if we extract the square-root of 2824·2829 (= 2218·192 ÷ ·7854,) we obtain the diameter of a circle whose area is exactly one bushel. The square-roots thus obtained are called "gauge-points," and being distinguished by a particular mark, are used as the first term, or ratio, in working problems similar to those in page 171.

The principal gauge-points used in excise calculations, and the square-divisors from which they are calculated, are given below; and others may be found and made when required by the foregoing process, it being recollected that when used on the line D, they are merely the square-roots of divisors which, in the ordinary method of calculations, it would be necessary to use for reducing from one denomination to another.

GAUGE-POINTS.

| Square divisors. | For finding | For squares, rectangles, &c. | For circles, cylinders, &c., see the divisors, page 91. | For conical vessels. | For spheres, &c. see the divisors, page 137. | For prismoids and vessels when the middle area is taken. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Square. | Circular |
| 1 | Inches......... | 1· | 1·12838 | 1·59441 | | 1· | 2·764 |
| 1728 | Solid feet...... | 41·569 | 46·905 | | | | |
| 277·274 | Gallons........ | 16 6516 | 18·7893 | 32·5441 | 23·0 | 40·7878 | 46·024 |
| 2218·192 | Bushels........ | 47·0977 | 53·1441 | 92·0490 | 65·1 | 115·3653 | 130 176 |
| 28·00 | lbs. wt. of hot hard soap.. | 5·291 | 5·9708 | | | | |
| 27·14 | Ditto cold ditto. | 5·2096 | 5·878 | | | | |
| 25·00 | Ditto hot silicated ditto. | 5· | 5·6418 | | | | |
| 24·23 | Ditto cold ditto. | 4·922 | 5·5543 | | | | |
| 8·64 | Pounds of flint glass....... | 2·939 | 3·316 | | | | |
| 11·302 | Do. plate glass. | 3·361 | 3·793 | | | | |

which is the circular gauge-point for gallons. These latter gauge-points are the diameters of a circle whose area is exactly one bushel, and one gallon, respectively.

On some sliding-rules there are other gauge-points, adapted to the particular business in which they are used.

TO FIND THE AREA OR CONTENT WHEN NOT MORE THAN TWO DIMENSIONS ARE GIVEN.—Set the gauge-point on D to the depth or height on C, then against the side or diameter (or the mean-proportinal, if two dimensions are given) on D is the area, or content, on C.*

---

Should a new gauge-point be required by reason of the given one falling off the rule, or otherwise, such new gauge-point may be found as follows:—

Set 1 on C to the gauge-point on D, and against the other 1 on C is the new gauge-point on D.

Gauge-points are applicable to regular polygons, as follows:—Divide 277·274 (or other square divisor) by the proper tabular multiplier, (see page 152) and extract the square-root of the quotient.

* EXAMPLES WHERE TWO DIMENSIONS ARE GIVEN.

(1.) Required the area in bushels of a square one inch deep, the side being 40 inches. (See page 117.)

| | On D | | on C | | on D | | on C. | |
|---|---|---|---|---|---|---|---|---|
| As | the gauge-point (M S) | : | 1 | :: | 40 | : | ·721 | The area. |

When the rule is set in this way it is a table of areas; for against any side of a square on D is the area on C.

(2.) What is the area in gallons of a circle, the diameter being 21·5 inches? (See page 120.)

| | On D | | on C | | on D | | on C. | |
|---|---|---|---|---|---|---|---|---|
| As | the gauge-point (G) | : | 1 | :: | 21·5 | : | 1·3 | Area in gallons. |

(3.) What is the content, in gallons and bushels, of a cube, the side of whose square is 40 inches? (See page 117.)

| | On D | | on C | | on D | | on C. |
|---|---|---|---|---|---|---|---|
| As | 16·65<br>47·19 (M S) | : | 40 | :: | 40 | : | 230·8 gallons.<br>28·85 bushels. |

(4.) What is the content, in gallons and bushels, of a cylinder, whose diameter is 38 inches, and depth 60 inches? (See page 121.)

| | On D | | on C | | on D | | on C. |
|---|---|---|---|---|---|---|---|
| As | 18·7 (G)<br>53·14 (M R) | : | 60 | :: | 38 | : | 245·4 gallons.<br>30·6 bushels. |

(5.) Required the content in gallons of a sphere whose diameter is 20 inches? (See page 137.)

| On D | | on C | | on D | | on C. |
|---|---|---|---|---|---|---|
| As 23 (gauge-point) | : | 20 | :: | 20 | : | 15·1 gallons, content. |

**TO FIND THE CONTENT WHEN MORE THAN THREE DIMENSIONS ARE GIVEN.**—Set the gauge-point for prismoids on D to the length on C, then opposite to the sides or diameters at the ends, and to twice that in the middle, on D, will be found three numbers on C, which, added together, will give the content.*

---

### EXAMPLE WHERE THREE DIMENSIONS ARE GIVEN.

(6.) Required the content in gallons, bushels, and pounds weight of hot hard soap, of a rectangle, or parallelopipedon, whose length is 45 inches, breadth 15 inches, and depth 30 inches?

Find a mean-proportional (see page 171) between the length and breadth, thus:

$$\text{As}\ \overset{\text{On C}}{15} \ :\ \overset{\text{on D}}{15} \ :\ \overset{\text{on C}}{45} \ :\ \overset{\text{on D.}}{26}\ \text{Mean-proportional.}$$

$$\text{Then, As}\ \overset{\text{On D}}{\left\{\begin{array}{l}16{\cdot}65\\47{\cdot}10\ (\text{M S})\\5{\cdot}29\end{array}\right\}} :\ \overset{\text{on C}}{30}\ ::\ \overset{\text{on D}}{26}\ :\ \overset{\text{on C.}}{\left\{\begin{array}{rl}73{\cdot}14 & \text{gallons.}\\91{\cdot}4 & \text{bushels.}\\724{\cdot}28 & \text{lbs. wt. of soap.}\end{array}\right.}$$

The area may be found in a similar manner, the depth being reckoned one inch; but this is more readily performed by the lines A and B. (See page 168.)

The content of rectangular vessels may be found in bushels at one operation by the line M D, *infra;* (and see page 176 as to Mr. Gutteridge's proposed new line of moveable gauge-points.)

### * EXAMPLES WHEN MORE THAN THREE DIMENSIONS ARE GIVEN.

(7.) What is the content in gallons of the frustum of a cone, the depth being 100 inches, and the diameters of the bases 18 and 12, respectively?

$$\text{As}\ \overset{\text{On D}}{46{\cdot}02}\ (\text{gauge-point, see page 173})\ :\ \overset{\text{on C}}{100}\ ::\ \overset{\text{on D}}{\left\{\begin{array}{c}18\\12\\30\end{array}\right\}}\ :\ \overset{\text{on C.}}{\left\{\begin{array}{r}15{\cdot}3\\6{\cdot}8\\42{\cdot}5\end{array}\right.}$$

$$\text{Content in gallons} \ldots\ldots\ \overrightarrow{64{\cdot}6}$$

(8.) What is the content in gallons of the frustum of a rectangular pyramid, the depth being 100 inches, the sides of the upper base 18 and 8 inches, and the sides of the lower base 27 and 12 inches, respectively?

$$\text{As}\ \overset{\text{On D}}{40{\cdot}79}\ (\text{see page 173})\ :\ \overset{\text{on C}}{100}\ ::\ \overset{\text{on D}}{\left\{\begin{array}{c}18\\12\\30\end{array}\right\}}\ :\ \overset{\text{on C.}}{\left\{\begin{array}{r}19{\cdot}47\\8{\cdot}65\\54{\cdot}09\end{array}\right.}$$

$$\text{Content in gallons} \ldots\ldots\ldots\ 82{\cdot}21$$

This rule, which, as well as the examples, is taken from *Ingram's Mathematics*, page 229, &c., is founded upon the calculations for finding the contents of prismoids in page 134. It is applicable to almost every description of solids where a middle diameter can be obtained, and is the most correct method of finding the content of a cask. (See "Cask-Gauging," *infra.*)

### 4. *Of the line* M D.

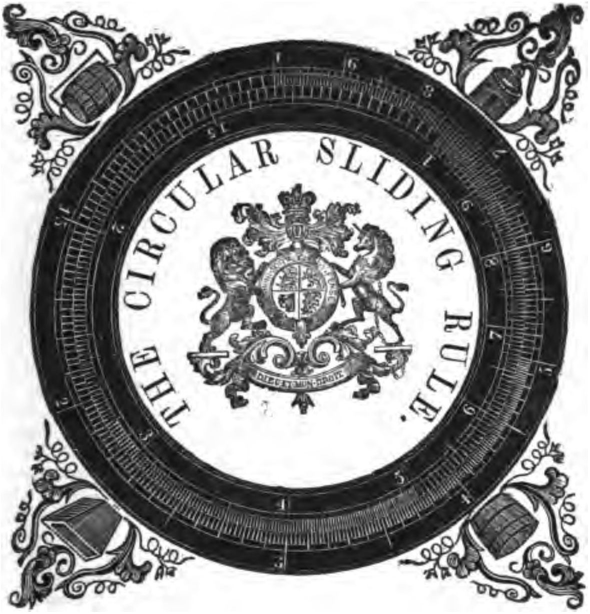
The line M D,* signifying "malt depth," is a similar line to A, B, and C, with this difference only, that it is a broken line of two radii; and the figures and sub-divisions stand in an inverted order, beginning at 2218·192, the number of inches in a bushel, numbered from the right hand to the left, ending at 2218·192, where it began.

This line is placed under one of the lines marked A, (but separated from it by means of the groove, which allows the sliders to pass through,) and so arranged, that

---

* I cannot ascertain who was the first to adopt this ingenious contrivance to the sliding-rule, but it seems to have been suggested by the remarkable proportions which two equal logarithmic lines bear to each other when one is inverted, or running in a direction contrary to the other. The nature of these proportions will be seen if we place the slider B in the groove under the line A, in an inverted position. In this position we can multiply any two numbers together by setting one of the factors on B to the other on A, the product will then be found on B, opposite 1 on A; we can also divide two numbers by placing the dividend on B against 1 on A, the quotient will then be found on either line opposite the divisor on the other. So to square any number, we have only to place it on B against the same number on A, and the square will be found on B against 1 on A; and so, also, if we set any number on B against 1 on A, the square-root of such number will be found where the numbers on the two scales coincide, that is, when some number on B stands against the same number on A. The line M D is founded upon these properties. The square-divisor for bushels is adopted for the commencement of an inverted line of numbers of the same power as the line A, and this divisor being exactly under unity on the line A, which stands above the slider, while the line M D is placed under it, the three lines can be used at one operation. Mr. Moss observes, that "the same examples may be performed with more ease to the learner by the lines A and B (see page 169), or with the lines C and D, after finding a mean-proportional between the length and breadth." (See page 174.) The experienced gauger, we believe, always prefers the use of the line M D, and if he checks his operations by Mr. Todd's excellent table of semi-squares, (see page 150,) he will generally arrive at a correct result.

Mr. Gutteridge remarks, that "it is not a little strange that this most admirable method of gauging an unequal sided floor of malt, without any other trouble than one mere touch of the slide, should not have been made for, and adopted, in gauging of every other species of measure; particularly as the tabulating of brewer's and other utensils is so very


THE CIRCULAR SLIDING RULE.
DIEU ET MON DROIT

the 1, or 10, on this line M D, is placed directly opposite to B, or M B, on the line A: and if this 1, or 10, be called 1000, the last division, at the left end of the rule, will denote, 2218·192, the cubic inches in a bushel; but if 10 be called 1, the last divison at this end will be 2·218 the same as the first division at the right hand end of the rule.

This line is used with the line A, and the slides B or C, for finding the content of rectangular and similar figures in bushels at one operation.

---

tedious. Yet," he adds, "so tedious is the application of the sliding-rule, even in the hands of the most expert, that, what with finding a mean, then setting to the gauge-point, then considering if the numbers be even or odd, in reference to the radius out of which the result is to be taken, &c., the sliding-rule is perfectly useless in such case; the operation, even by the old tedious methods by the pen, being far preferable." To remedy this inconvenience, he proposed that the line M D should be moveable, and that, on its reverse side, a similar line should be graduated for ale gallons. He also suggested that a double radius of inverted logarithms, opening and closing with a hinge, should be substituted, when necessary, for the line M D, the respective gauge-points on which (being in this case divisors) should be brought forward when wanted, and placed even with 10 on the right hand of A; and when so placed, the rule-line could be used in conjunction with the line B, for any measure whatever, so as to obtain the content at one operation in the same manner as the line M D is used for bushels. These suggestions do not appear to have been acted upon to any extent, and we apprehend the practical officers would have a decided objection to the line M D being moveable, for fear of mistakes; but we consider that an additional line of numbers, with a line of inverted logarithms, extending beyond a single radius, so as to serve for measures of every description, would be a decided improvement.

An ingenious device, in connexion with the line M D, was adopted some time ago by Mr. Morrison, supervisor of excise. This line, as well as the lines A and B, was graduated in a circle, so as to fit on the top of the box in which the measuring-tape is usually coiled up; and the line B was made to revolve instead of sliding backwards and forwards. By this method malt areas could be worked as soon as the dimensions were taken. (See the Engraving.)

Officers of the revenue desirous of providing themselves with sliding-rules constructed with Mr. Gutteridge's additional line, or Mr. Morrison's revolving line, or Mr. Woollgar's line X, (*infra*), may obtain the same, as well as gauging-instruments of every other description, of the publisher, MR. COOK, *of the Store Office, at the Chief Office of Excise, London.*

To FIND THE AREA OF A RECTANGULAR FIGURE.—Set the length on B to the breadth on M D, then opposite to 1 on M D is the area on B.[*]

To FIND THE CONTENT OF RECTANGULAR VESSELS IN BUSHELS, AT ONE OPERATION.—Set the length on B to the breadth on M D, then against the depth on A will be the content on B.[†]

---

[*] DEMONSTRATION.

The measure of the breadth being $b$, and that of its length $l$, the measure of the rectangle is $b \times l$; hence, $q = b \times l$, or $L : q = L : b + L : l$. Now, when $b$ on B is set to $l$ on M D, then 1 on M D is against a number on B, which is distant from $b$ towards the right hand by the space 1, $l$; so that 1 on M D is against a number on B, which is distant from 1 by the sum of the spaces 1 $b$ and 1 $l$; but those spaces are logarithms of their numbers, whence the distance of the number on B opposite 1 on M D is expressed by $L : b + L : c$, and therefore the number itself is $l \times b$ or $q$. Q. E. O.—*Shirtliffe's Gauging*, 52.

EXAMPLES OF RECTANGULAR AREAS.

(1.) Let a rectangular figure be 50 inches in length and 30 in breadth; required its area?

| On M D | | on B | | on M D | | on B. | |
|---|---|---|---|---|---|---|---|
| As 70 | : | 30 | :: | 1 | : | 1500 | Area in inches. |

If the area be required in bushels, either of the dimensions on M D may be placed opposite the other on B, then against 1 on A, (or the commencement of the broken line M D,) is the area on B. Thus, in the foregoing example

| On B | | on M D | | on A | | on M D. | |
|---|---|---|---|---|---|---|---|
| As 50 | : | 30 | :: | 1 | : | ·677 | Area in bushels. |

[†] DEMONSTRATION.

The length being $l$, breadth $b$, height $h$, and the area of the base $q = l \times b$, the content is $q \times h \div 2218{\cdot}192$; but by the last proposition $q$ is against 1 on M D, therefore, by the rule of proportion (see page 168), if 2218·192 on A be set to $q$ on B, then against $h$ on A is $h \times q \div 2218{\cdot}192$ on B. But 2218·192 on A is opposite 1 on M D, and 1 on M D has been already shown to be against $q$ on B; therefore, 2218·192 on A is against $q$ on B, whence, against $h$ on A is the content on B, namely, $h \times q \div 2218{\cdot}192$.—*Shirtliffe's Gauging.*

EXAMPLE FOR FINDING THE CONTENT IN BUSHELS.

(2.) What is the content of a couch, cistern, or floor of malt, the length being 45 inches, breadth 15 inches, and depth 12 inches?

| On B | | on M D | | on A | | on B. |
|---|---|---|---|---|---|---|
| As 45 (length) | : | 15 (breadth) | : | 12 (depth) | : | 3·65 (content in bushels.) |

### 5. *Of the line* X.

THE line X is a line of special gauge-points, applicable to the gauging of casks. It has been recently invented by Mr. Woollgar, of Lewes, and is graduated in the annexed engraving at the right hand of the groove, under the first slider, as will be seen by lifting up the slit part of that slider near the middle 1 or 10. It is used in conjunction with the lines A, B, C, and D.[*]

TO FIND THE CONTENT OF A CASK.—Set the head-diameter on A against the bung-diameter on B; and the slider B being thus drawn out a little to the left, the right hand end of it at 1 (a single radius only being used) will cut the line X in the groove at a special gauge-point, which must be reserved; then set this special gauge-point on D against the length on C, and opposite the bung-diameter on D will be the content in gallons on C.[†]

---

[*] In a communication to the *Mechanic's Magazine*, No. 849, Mr. Woollgar pointed out the mode in which this new line might be applied to the general rule for cask-gauging, to which Dr. Hutton assigns the highest rank for accuracy and facility, and which, as applicable to imperial measure, and dimension taken in inches, may be expressed thus: $\text{C} = \cdot000031473\,\text{L}\,(39\,\text{B}^2 + 25\,\text{H}^2 + 26\,\text{B}\,\text{H})$. The line X, which for this purpose it is necessary to lay down in the groove of the rule, is, in fact, a line of special gauge-points, applicable to the different proportions between the head and bung-diameters.

Mr. Woollgar has favoured us, for the exclusive use of the excise department, with a graduation of this line, adapted to that curvature of casks commonly known as the 2nd variety, and the following table of logarithms, on which the graduation is made from a scale of equal parts, whereof 10000 is equal to the radius of the line A.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21·5 | ·7759 | 20·8 | ·8428 | 20·1 | ·9023 | 19·4 | ·9563 |
| ·4 | ·7860 | ·7 | ·8517 | 20·0 | ·9103 | ·3 | ·9636 |
| ·3 | ·7959 | ·6 | ·8605 | 19·9 | ·9182 | ·2 | ·9709 |
| ·2 | ·8056 | ·5 | ·8691 | ·8 | ·9260 | ·1 | ·9781 |
| ·1 | ·8151 | ·4 | ·8776 | ·7 | ·9338 | 19·0 | ·9852 |
| 21·0 | ·8245 | ·3 | ·8860 | ·6 | ·9414 | 18·79 | ·0000 |
| 20·9 | ·8337 | ·2 | ·8942 | ·5 | ·9489 | | |

[†] EXAMPLE OF A CASK.

(1.) Let the length of a cask be 40 inches, its bung-diameter 32, and its head-diameter 24 inches; required its content.

## 6. *Of the Variety-Lines.*

THE lines marked "Sphd.," for *spheroids*, and "2 var." for *second variety*, are respectively divided into certain equal distances, laid down against a line of inches and tenths, for finding the mean-diameters of casks of what are called the first and second varieties, for the purpose of reducing them to cylinders, the more easily to calculate their contents.[*]

## 7. *Of the Ullage-Lines.*

THE ullage-lines are two lines marked "Seg. St." or "S. S.," signifying *segment standing;* and "Seg. Ly." or "S. L.," signifying *segment lying.* The line S. S., is numbered from the left to the right with 1, 2, 3, 4, 5, 6, 7, 8, and continued on another line with 9, 10, 20, 30, &c., to 100, and being placed on the rule so as to work with the slider B, or C, is used for finding the ullage of a standing cask, or the quantity of liquor it contains when it is not full.

The line S. L. is numbered in a manner nearly similar, and used for ullaging lying casks.[†]

---

Set 24 on A against 32 on B, and at the end of the radius the slider will ut the line X at 20·4.

On D on C on D on C.

Then, as 20·4 : 40 :: 32 :: 98·1 Content in gallons.

(See "Cask-Gauging," *infra.*)

[*] These lines are not much used at present. Mr. Shirtliffe observes, that 'as the calculation is so easily made without a mean-diameter, it is not worth spending any time on their explanation."

[†] Mr. Shirtliffe, in his "Gauging," (1740,) stated that he could not ascertain by whom these ullaging-lines were first introduced into gauging, nor the manner in which they were laid down. The following directions for graduating such lines are from *Moss's Gauging*, pages 94, 95:—"Take a cask whose content is 100 gallons, and the nearest in form to those which frequently occur in practice; then suppose the bung-diameter, or length, (according to the position of the cask,) divided into 100 equal parts, which must be laid down on a moveable slide in a logarithmic manner, by the method already described (see page 164). Draw out, and carefully measure, successively, the quantities contained in the first, second, third,

TO ULLAGE A CASK.—Set the length, or bung-diameter, on B, or C, to 100 on A, and against the wet inches on B, or C, is a number upon S. S. or S. L. (according as the cask is standing or lying) to be reserved; then set 100 on B to this reserved number on A, and opposite to the content on B will be found the ullage on A.*

---

fourth, and fifth, &c., of those equal divisions of the bung-diameter (or length); then place the quantity contained in the first, in the first two, first three, first four, &c., of those equal divisions exactly against the numbers 1, 2, 3, 4, &c., respectively on the slide, and so, by proceeding in this manner, we shall obtain the true quantity in such cask to every hundredth-part of its bung-diameter, or length. And if either of these were supposed to be divided into any other number of equal parts (besides 100), and the quantities contained in the first, first two, first three, &c., of those equal parts be placed exactly opposite the numbers 1, 2, 3. &c., respectively, on the slide, we should thereby obtain a table of segments for a standing or lying cask similar to the former. Whence, the reason of finding what is called the segment is very evident, for it is only conceiving the bung-diameter (or length) of that cask, from which the lines of segments were supposed to be constructed, to be divided into as many equal parts as there are inches, &c., in the bung-diameter (or length) of the cask whose ullage we are then seeking, and placing the number against 100 on the segments, then opposite any proposed number of wet inches, &c., (or equal parts of the bung-diameter, or length,) we shall have the segment sought."

On some rules the slider used with the segment-lines is marked "N."

* EXAMPLES IN ULLAGING.

(1.) Suppose the length of a standing cask to be 40 inches, the wet inches 10, and the content 92 gallons; what is the ullage, or content of the wet inches?

On B on A or S S on B on S.S.
As 40 : 100 :: 10 : 23 (to be reserved.)
On B on A on B on A.
Then, As 100 : 23 :: 92 . 21·2 gallons, the ullage.

(2.) Suppose the bung-diameter of a lying cask to be 33 inches, the wet inches 22, and the content 120 gallons; what is the ullage?

On B on A or S L on B on S L.
As 33 : 100 :: 22 : 72·4
On B on A on B on A.
Then, As 100 ; 72·4 :: 120 : 87 gallons, the ullage.

The same rule will also give the content of the space taken up by the dry inches.

## PART II. GAUGING OPEN VESSELS.

OPEN VESSELS are such as can be measured at the inside; and for the purposes of the present work may be considered to comprehend all utensils under the survey of the officers of excise, except casks. As most of these vessels are either in, or can be reduced to, the form of solids, rules for measuring which have been given in the foregoing chapter; it will only be necessary, in this place, to give some hints for the proper application of such rules to the actual business of the excise officer.

As an officer has frequently, in the course of his duty, to inspect the same utensil, he takes an opportunity (when it is empty if possible) of ascertaining the quantity it will hold when full, and also at every inch, and sometimes at every tenth of an inch of its depth, so as to enable him, on his periodical visits, to ascertain the quantity of materials which may be in the vessel by an easy method of computation. The operations by which these particulars are obtained are called *gauging*, *tabulating*, and *fixing*.

The dimensions of all vessels are taken in inches and tenths, and from thence reduced to the denomination in which the duty is charged, or the official account kept. The instruments employed in taking these dimensions are graduated scales of different kinds, called dimension-canes, measuring-rods, &c. In gauging large malt floors a graduated measuring tape is used; and sometimes other instruments are employed, according to the nature of the business to be performed.

Open vessels are either 1, Regularly formed vessels; 2, Vessels whose forms are nearly regular; 3, Irregularly formed vessels; or 4, Stills.

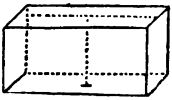
### 1. *Of Regularly Formed Vessels.*

**Regularly** formed vessels are such as have their dimensions of a strictly geometrical construction. Among these may be reckoned Malt Couch Frames, Soap Frames, and a few other utensils belonging to Maltsters, Distillers, &c.

**To gauge a malt couch frame, soap frame, or other rectangular vessel***.—With a proper gauging-

---

* **EXAMPLE OF A MALTSTER'S COUCH FRAME.**



(1.) Suppose the dimensions of a maltster's couch-frame, taken according to the rule, to be as follows: length 45 inches, breadth 15 inches, and depth 12 inches. The area, (see page 118,) is found as follows:—

$$45 \times 15 = 675 \div 2218{\cdot}192 = {\cdot}304 \text{ bushels.}$$

Thus entered in the table-book:

Mr. A. B.'s Malt Couch-Frame.

| Depth. | Length. | Breadth. | Area. |
|---|---|---|---|
| 12·0 | 45·0 | 15·0 | ·304 |

No further tabulation of a vessel of this description is necessary; and the officer's periodical gauge consists in merely ascertaining the depth of the materials contained therein at the time, and multiplying such depth by the area; the product will give the actual content or quantity of materials in the vessel, which must be entered in the survey-book. Thus, suppose the depth of corn in the above malt couch-frame be found to be 10 inches; the content will be as follows: 10 × ·304 = 3·04 bushels.

In finding the depth of the corn in this vessel, (as in every other maltster's utensil,) it is usual to take a number of dips in different parts of the utensil in order to ascertain whether the surface is level, and if there be a slight variation in the depth, the different dips are added together and divided by their number for a mean depth. Thus, in the foregoing example, if there had been ten dips of the corn, (as follows,) the mean-depth would have been taken at 10, as before, and the result would have been the same.

$$\begin{array}{rl} & 9{\cdot}8 \\ & 9{\cdot}8 \\ & 9{\cdot}8 \\ & 9{\cdot}9 \\ & 9.9 \\ & 10{\cdot}2 \\ & 10{\cdot}0 \\ & 10{\cdot}2 \\ & 10{\cdot}2 \\ & 10{\cdot}2 \\ \hline 10\,) & 100{\cdot}0 \\ \hline & 10 \text{ Mean depth.} \end{array}$$

Rectangular cisterns and kilns are gauged in the same manner, as are rod carefully measure the length, breadth and depth of the vessel; find the area thereof in the proper denomination, according to the rule in mensuration; and enter such dimensions and area in the dimension-book.

---

also malt floors, (which are usually in a rectangular form,) except that in this case the area is not previously found; the content is, therefore, calculated by multiplying the length, breadth, and mean-depth together, and reducing the product to bushels. (See page 118.)

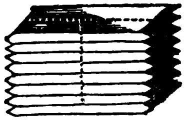
It may be proper, in this place, to notice, that in calculating the content of malt in its various stages of operation, allowances are made upon a presumption that 100 cistern or couch-bushels, or 163 floor-bushels, gauged after the grain has been emptied out of the cistern, will make only 81·5 net-bushels.

To reduce any given number of *cistern*-bushels to their equivalent in dry malt, multiply the cistern or couch-bushels by ·815, and the product will be the equivalent in net-bushels.

To reduce any number of *floor*-bushels, multiply the given number by ·5, the product will be the equivalent number of net-bushels.

To find whether a floor-gauge will produce a better charge than the cistern or couch-bushels to which such floor belongs, multiply the amount of the best cistern or couch-gauge by 1·63, and if the product be equal to, or exceed the amount of the floor-gauge, the best cistern or couch-gauge will be the charge; but if that product be less than the amount of the floor-gauge, the floor-gauge will be the charge.—*Board's Instructions.*

EXAMPLE OF A SOAP FRAME.



(2.) Let the annexed figure represent a hard soap frame, the length being 45 inches, and the breadth 15; required its hot and cold area.

$45 \times 15 = 675 \div 28 = 24{\cdot}107$ Hot area.

$45 \times 15 = 675 \div 27{\cdot}14 = 24{\cdot}87$ Cold area.

Thus entered in the dimension-book:—

Mr. A. B.'s Hard-Soap Frame.

| | Length. | Breadth. | Hot area. | Cold area. |
|---|---|---|---|---|
| No. 1. | 45 | 15 | 24·107 | 24·87 |

If the warm gauge or depth of soap in this frame be found at any time to be, say 240 inches, the content to be entered in the survey-book will be calculated as follows:—

$24{\cdot}107 \times 240 = 5784$ lbs.

A mash tun may be gauged in the same way if the dimensions are exactly regular, which, however, is seldom the case. When there is any deviation from the perpendicular, cross-diameters must be taken, as directed in the next section.

TO GAUGE A VESSEL IN THE FORM OF A CYLINDER.*—With a proper gauging-rod carefully measure the diameter and depth of the vessel; find the area thereof in the proper denomination, and enter such dimensions and area in the dimension-book.

TO GAUGE A VESSEL IN THE FORM OF A FRUSTUM OF A CONE OR PYRAMID.†—With a proper gauging-rod find the diameter (or sides) of the top and bottom of the vessel; calculate the area, and enter the same with the dimensions in the dimension-book.

---

* EXAMPLE OF A CYLINDRICAL VESSEL.

(3.) Suppose the dimensions of a distiller's store-cask in the form of a cylinder, taken according to the rule, to be as follows:—Diameter 38 inches, depth 60 inches.

The area found by the table of circular areas, (see page 155,) is 4·0902.

Thus entered in the dimension-book:—

Mr. A. B. Distiler's Store-Cask.

| Diameter. | Depth. | Area. |
|---|---|---|
| 38·0 | 60·0 | 4·0902 |

The quantity of liquor at any time found in this vessel is ascertained by measuring the depth of such liquor, and multiplying the same by the area.

If the sides be not perpendicular, the vessel must be measured by the rules given in the next section.

† EXAMPLE OF A VESSEL IN THE FORM OF A CONICAL FRUSTUM.

(4.) Suppose the dimensions of a distillery utensil in the form of the frustum of a cone to be as follows:—Top diameter 40 inches, bottom diameter 25 inches, depth 30 inches. The content may be found, as in page 130.

If it be required to find an exact intermediate diameter of the vessel at any required depth, it may be found by means of a *differential factor*, which may be obtained by the following rule:—From the greater diameter subtract the less, and divide the remainder by the depth of the vessel; the quotient will give the *differential factor* required, and which may be used for finding the required diameter at any proposed depth of the vessel, as follows: Multiply the proposed depth by the differential factor; add the product to the less diameter, if the proposed depth is reckoned from the smaller end; or *subtract* such product from the greater

TO GAUGE A VESSEL IN THE FORM OF A SPHERICAL SEGMENT.—Take two cross-diameters, (which ought to be equal,) at the level of the lowest part of the mouth, and consider half their sum as the mean-diameter of the segment's base; take also the depth of the vessel: find the content by the proper rule in mensuration, and enter these particulars in the table-book. From the foregoing dimensions calculate the content at every inch of the vessel's depth, and enter the same in the dimension-book.*

---

diameter if the proposed depth is reckoned from the larger end; the sum or difference, as the case may be, will be the diameter at the depth proposed. Thus, if it be required to find intermediate diameters of the above vessel at every five inches of its depth, the same may be found as follows:—

$$40 - 25 = 15 \div 30 = \cdot 5 \quad \text{Differential factor.}$$

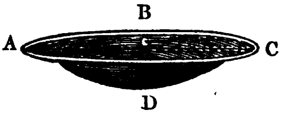
| Then, | | | But; | | |
|---|---|---|---|---|---|
| 5 × ·5 = 2·5 | increase of diameter at | 5 inches | 25 + 2·5 = 27·5 | diameter at | 5 inches deep. |
| 10 × ·5 = 5·0 | | 10 .. | 25 + 5·0 = 30·0 | | 10 |
| 15 × ·5 = 7·5 | | 15 .. | 25 + 7·5 = 32·5 | | 15 |
| 20 × ·5 = 10·0 | | 20 .. | 25 + 10 = 35·0 | | 20 |
| 25 × ·5 = 12·5 | | 25 .. | 25 + 12·5 = 37·5 | | 25 |

If the wider end had been uppermost, the numbers found by the factor would have been *deficiency* of diameter instead of increase, and must have been severally subtracted from 40, the greater diameter.

By this mode it is evident that the content of every inch or tenth of an inch might be found, if required, and entered in the Table Book.

A vessel in the form of a square pyramidical frustum might be gauged in a similar manner; but all vessels of this description are usually measured by means of cross diameters taken at every ten inches in the manner directed for distillery utensils, &c. (*Vide infra.*) Vessels of this kind are, indeed, seldom found in the form of a perfect frustum, there being usually a difference of an inch, or an inch and a half, between the true diameters taken in different parts, according as the vessel is of greater or less magnitude.

* EXAMPLE OF A SPHERICAL SEGMENT:



(5.) Let A B C D be a copper pan in the form of a spherical segment to be gauged and inched, and suppose the diameter to be 90 inches; and the depth, B D, 15 inches.

To find the area at each inch of the depth it will first be necessary to find the diameter of the sphere of which the vessel is supposed to form a part; which is done by dividing the square

### 2. *Of Vessels whose Forms are nearly Regular.*

MANY of the vessels used for the deposit of exciseable articles are not exactly regular, but nearly so; and where the departure from a strict geometrical form is only slight, it is the practice to find a *mean* of the dimensions which so vary, and by the use of such mean to consider the vessel as reduced or raised into the geometrical form to which it nearly approaches; thus obtaining an approximation, and sometimes a very close one, to the actual content of the vessel. Among vessels of this description are various spirit-receivers, store-vats, glass-pots, mash-tuns, coolers, and other utensils, which are frequently found in forms very nearly resembling cylinders, rectangles, or frustums of a cone or square pyramid. Elliptical vessels are considered irregular, and are to be gauged by the rules given in the next section, except spirit dealer's small store-casks, which are usually gauged by the rules given in the present section, as no charge of duty arises from their contents.

---

of half the base by the altitude of the frustum, and adding to the quotient the altitude: the sum is the diameter of the sphere; thus:

$90 \div 2 = 45 \times 45 = 2025 \div 15 = 135 + 15 = 150$ Diameter of the sphere.

Then for the diameter of the segment at any given inch of the depth, subtract the given number from the diameter of the sphere, and multiply the remainder by the same given number; twice the square-root of the product will be the diameter required. Thus, to find the diameter at one inch deep, say:

$150 - 1 = 149 \times 1 = 149$ Square-root $12{\cdot}2 \times 2 = 24{\cdot}4$.

In the same way the diameter at every inch may be obtained, from which the area in gallons may be calculated as for circles, or found by reference to the Table of Areas, (see page 155.) The segment at the bottom may be found by the rule in page 138, and, when added to the area for every inch, will give the whole content of the vessel. *(Vide stills, infra.)*

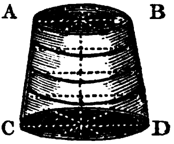
If the vessel be a brewer's utensil the areas are reduced, as the work proceeds, to barrels, firkins and gallons, (see page 52.) In other respects the tabulation and entry in the dimension-book are the same as vessels gauged by means of cross-diameters and the globular parts of a still-head, examples of which, set out at length, will be found in the proper place.

TO GAUGE AND TABULATE A LARGE DISTILLERY, OR OTHER UTENSIL, WHOSE FORM IS NEARLY CIRCULAR.*—With a chalk-line, mark lines in the bottom of the vessel, so as to divide the same into eight equal parts, as directed in page 105. From the top of the vessel let fall perpendiculars on the diameters before struck; and from the extremities of the diameters to the points whence the perpendiculars were let fall, strike up the sides of the vessel the lines on or between which cross diameters are intended to be taken. Fix upon and mark a proper dipping place, let fall therefrom a plumb-line, and mark the point where

---

* EXAMPLE OF A LARGE DISTILLER'S SPIRIT RECEIVER.

(1.) Let A B C D represent a circular distillery spirit-receiver, to be gauged and tabulated; and suppose the dimensions taken according to the above rule to be contained in the following table, which also shews the area and content.



Mr. A. B.'s Spirit Receiver, gauged 10th October, 1834, by C. D. E. F. & G. H.

| Depths. | Cross-Diameters. | | | | Mean Diameters. | Incumbrance. | | Gross Area. | Net Area. | Content in gallons. |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | | Depths | Area. | | | |
| 08·7 | 110·1 | 110·7 | 110·0 | 110·5 | 110·4 | 04·2<br>04·5 | 1·4979 | 34·5238 | 33·0259<br>34·5238 | 138·7087<br>155·3571 |
| 10·0 | 112·0 | 112·4 | 112·1 | 112·5 | 112·2 | | | 35·6587 | .. | 356·5870 |
| 10·0 | 113·8 | 113·6 | 113·7 | 113·5 | 113·6 | | | 36 5542 | .. | 365·5420 |
| 10·0 | 115·4 | 115·6 | 115·5 | 115·4 | 115·5 | | | 37 7871 | .. | 377·8710 |
| 09·1 | 117·2 | 117·3 | 117·2 | 117·1 | 117·2 | | | 38·9077 | .. | 354·0600 |
| 00·9 | Drip per Measure........................................ | | | | | | | | | 27·0000 |
| 48·7 | Depth | | | | | | | | Content.. | 1775·1258 |

Incumbrance—A Beam across the Top.

L. 109·3 } Inches—Area 1·4979 gallons to be deducted
B. 03·8 } from the Area of the first 04·2 inches from
D. 04·2 } the top.

The area for every inch of the depth is found as follows:—Add the area of the first section to itself, and the sum will be the content at two inches of the depth; to this add the same area, and the sum will be the content at three inches, and thus continue, adding the area of the first section, for the plummet touches the bottom of the vessel. Carefully ascertain the distance between the point so marked and the dipping place; which distance will be the depth of the vessel in the position in which it stands. Then measure cross diameters between the different lines up the sides of the vessel, at every five, six, or ten inches, according as the form of the vessel deviates, more or less, from the form of

---

as many inches as it is deep. To the content of the first section add the area of the second, and so continue to the bottom, changing the area at the commencement of each section. If there be a drip, as in this case, it is first brought into the tabulation.

METHOD OF TABULATION.

| Wet Inches. | | |
|---|---|---|
| Drip | 00·9 | 27·0000 |
| $\frac{1}{10}$ Lower Area | | 3·8907 |
| 1 | .. | 30·8907 |
| | | 38·9077 |
| 2 | .. | 69·7984 |
| 3 | .. | 108·7061 |
| | | 38·9077 |
| 4 | .. | 147·6138 |
| 5 | .. | 186·5215 |
| | | 38·9077 |
| 6 | .. | 225.4292 |
| 7 | .. | 264·3369 |
| | | 38·9077 |
| 8 | .. | 303·2446 |
| 9 | .. | 342·1523 |
| | | 38·9077 |
| 10 | .. | 381·0600 |
| | | 37·7871 |
| 11 | .. | 418·8471 |
| 12 | .. | 456·6342 |
| | | 37 7871 |
| 13 | .. | 494·4213 |
| 14 | .. | 532·2084 |
| | | 37·7871 |
| 15 | .. | 569·9955 |
| 16 | .. | 607·7826 |
| | | 37·7871 |
| 17 | .. | 645·5697 |
| 18 | .. | 683·3568 |
| | | 37·7871 |
| 19 | .. | 721·1439 |
| 20 | .. | 758·9310 |
| | | 36·5542 |
| 21 | .. | 795·4852 |
| 22 | .. | 832·0394 |
| | | 36·5542 |
| 23 | .. | 868·5936 |
| 24 | .. | 905·1478 |
| | | 36·5542 |
| 25 | .. | 941·7020 |
| 26 | .. | 978·2562 |
| | | 36·5542 |
| 27 | .. | 1014·8104 |
| 28 | .. | 1051·3646 |
| | | 36·5542 |
| 29 | .. | 1087·9188 |
| 30 | .. | 1124·4730 |
| | | 35·6587 |
| 31 | .. | 1160·1317 |
| 32 | .. | 1195·7904 |
| | | 35·6587 |
| 33 | .. | 1231·4491 |
| 34 | .. | 1267·1078 |
| | | 35·6587 |
| 35 | .. | 1302·7665 |
| 36 | .. | 1338·4252 |
| | | 35·6587 |
| 37 | .. | 1374 0839 |
| 38 | .. | 1409·7426 |
| | | 35·6587 |
| 39 | .. | 1445·4013 |
| 40 | .. | 1481·0600 |
| | | 34·5238 |
| 41 | .. | 1515·5838 |
| 42 | .. | 1550·1076 |
| | | 34·5238 |
| 43 | .. | 1584·6314 |
| 44 | .. | 1619·1552 |
| $\frac{5}{10}$ 2d Area<br>$\frac{5}{10}$ 1st Area | | 33·7748 |
| 45 | .. | 1652·9300 |
| | | 33·0259 |
| 46 | .. | 1685·9559 |
| 47 | .. | 1718·9818 |
| | | 33·0259 |
| 48 | .. | 1752·0077 |
| $\frac{7}{10}$ 1st Area | | 23·1181 |
| 48·7 | .. | 1775·1258 |

In forming tables of this description it is not necessary to write down (as above) the area at every inch, but only to enter it on a piece of paper, and move it downwards as we subtract or add, according as the table is to be made for wet or dry inches.

a cylinder. Calculate the areas of each portion of the vessel by adding the four diameters together, and taking one-fourth of the sum for a mean-diameter of the particular section which they represent. Multiply the depth of each frustum or part by the mean-area for the content, and add the contents of the different frustums together for the content of the whole vessel. If there be any incumbrance, calculate the content thereof and deduct the same

---

Only the result of this tabulation is entered in the dimension book, which is done as follows :—

TABLE OF THE VESSEL.

| Wet Inches. | Gallons. | Area of a Tenth | Wet Inches. | Gallons. | Area of a Tenth | Wet Inches. | Gallons. | Area of a Tenth | Wet Inches. | Gallons. | Area of a Tenth. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 00·9 | 27 | | 13 | 494 | | 26 | 978 | | 39 | 1445 | |
| 1 | 31 | | 14 | 532 | | 27 | 1015 | | 40 | 1481 | — |
| 2 | 70 | | 15 | 570 | 3·778 | 28 | 1051 | 3·655 | 41 | 1515 | |
| 3 | 109 | | 16 | 608 | | 29 | 1088 | | 42 | 1550 | 3·452 |
| 4 | 148 | | 17 | 645 | | 30 | 1124 | — | 43 | 1585 | |
| 5 | 186 | 3·890 | 18 | 683 | | 31 | 1160 | | 44 | 1619 | — |
| 6 | 225 | | 19 | 721 | | 32 | 1196 | | 45 | 1653 { | $\frac{5}{10}$3·452<br>$\frac{5}{10}$3·302 |
| 7 | 264 | | 20 | 759 | — | 33 | 1231 | | | | |
| 8 | 303 | | 21 | 795 | | 34 | 1267 | | 46 | 1686 | |
| 9 | 342 | | 22 | 832 | | 35 | 1303 | 3·565 | 47 | 1719 | 3·302 |
| 10 | 381 | — | 23 | 868 | 3·655 | 36 | 1338 | | 48 | 1752 | |
| 11 | 419 | | 24 | 905 | | 37 | 1374 | | 48·6 | 1775 | — |
| 12 | 457 | | 25 | 942 | | 38 | 1410 | | | | |

In the foregoing table, when the decimal parts of a gallon amount to six tenths, a gallon is taken, and any less fraction is disregarded, and the same practice has usually been adopted in finding the mean-diameter, when the sum of the cross diameters was divided by their number; but it is better to calculate by the correct numbers.

Had the vessel been gauged for dry inches, instead of setting out the distances from the bottom, and taking the dimensions in the middle, as in the preceding example, the distances must have been set out from the top, and the dimensions taken in the middle of such distances, the area of the incumbrance being deducted from the area of that part of the depth in which such incumbrance is placed; thus.

Depths.
10·0
10·0
10·0
10·0
07·8
00·9 Drip.
48·7 Gross Depth.

In taking the cross-diameters, it must be recollected that "when great exactness is required, the number of areas in every vessel (whether straight out of the frustum or frustums to which it extends; and if there be a drip or fall in the vessel ascertain the quantity of liquor required to cover the bottom of the vessel by measuring liquor out of it by a known measure; then calculate the content of the vessel for every inch of its depth, beginning from the top, if the vessel be tabulated for dry inches, and at the bottom, if for wet inches: and enter the dimensions in the Table Book.

---

or curve-sided) should be such, that the increase of the cross-diameters or dimensions may not exceed one inch; in order to obtain which in a straight-sided vessel, the height of the vessel may be divided by the difference of the top and bottom diameters, (or dimensions,) and the quotient will be the perpendicular distance which the cross-diameters, &c., are to be taken from each other.

"If the difference of the cross-diameters of a vessel is pretty considerable, (that is four, five, or six inches, more or less, according to its magnitude,) then every practical gauger who is more solicitous for truth than expedition, will have recourse to the *general method* of equidistant ordinates; (page 101,) there being no other method that I know of for determining, with such an amazing degree of certainty, the measure of a curvilineal figure whose true form, (or property,) is unknown."—*Moss's Gauging*, page 118; and see irregular vessels *infra.*

The most convenient distance for the cross-diameters is ten inches, because in multiplying the area corresponding to each mean-diameter by 10, it is only necessary to remove the decimal point one place towards the right hand.

When the difference of the top and bottom diameters, (or dimensions,) of any straight-sided vessel is small, the distance of the cross-diameters may be set off upon the side without sensible error; but when such difference is large, the true account must be obtained by the rule in the next section, and set off accordingly.

The best method of obtaining the true dipping-place with a plumb-line is this: rub the bottom of the plummet well with chalk, &c., by which means, when the plumb-line is let down from the intended dipping-place, you will readily discover a mark made on the bottom of the vessel, upon which mark the end of the dimension-cane must be placed.—*Moss's Gauging*, page 161. Or use a plummet with a point, which will stick into the bottom of the vessel where it falls.

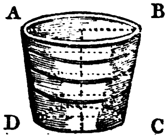
Sometimes the position of a distiller's wash back, &c, is such that it is found necessary to fix the dipping-place thereof at some certain distance above the top of the back, which distance is called the *curb;* and to avoid unnecessary trouble in tabulating the vessel, it is always taken a whole number of inches.—*See the examples in the next Section.*

**TO GAUGE AND TABULATE A SMALL DISTILLERY OR OTHER UTENSIL WHICH IS VERY NEARLY CIRCULAR.***— With a proper gauging-rod take cross-diameters at right angles at the top of the vessel; multiply the diameter by ·707, and the product will give the inscribed square, nearly. Having, by trial, found the true side of the inscribed square, mark the angular points, from each of which let fall a plumb-line, and mark the spot where the plummet touches the bottom; strike a line across the bottom, each way, so as to pass through the opposite marks. Draw straight lines from the bottom quarterings to the top, and take cross-diameters at every ten inches from the bottom, or nearer, if necessary. Add the cross-diameters of each section or frustum together, and take half the sum for a mean area of the part which it represents; calculate the areas of the different parts and the content of the whole, and tabulate the same in manner directed by the preceding rule.

---

* EXAMPLE OF A STORE VAT.

(2.) Let A B C D represent a store vat, made of a hogshead or cask, standing on one end, the other end being cut off, to be gauged and tabulated. Suppose cross-diameters to be taken according to the rule, the dimensions of which, with the areas and contents, are set out in the following Table.



Mr. A. B.'s STORE VAT.

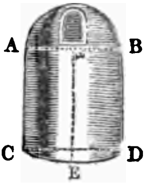
| Depths. | Cross-diameters. | | Mean-diameters. | Area gallons. | Content gallons. |
|---|---|---|---|---|---|
| 10 | 50·7 | 50·5 | 50·6 | 7·2524 | 72·524 |
| 10 | 51·6 | 51·4 | 51·5 | 7·5126 | 75·126 |
| 10 | 48·6 | 48·4 | 48·5 | 6·6629 | 66·629 |
| 10 | 44·7 | 44·5 | 44·6 | 5·6344 | 56·344 |
| 40 whole depth. | Whole content in gallons 270·623 | | | | |

The tabulation is made in the same way as in the last example.

TO GAUGE A GLASS POT.—With a diameter-rule find the top and bottom diameters, and also the depth of the pot; and if the pot approaches very nearly to the shape of a cylinder, add the two diameters together, and take half that sum for a mean-diameter, and find the area of a circle whose diameter is equal to such mean for the area of the

---

### EXAMPLES OF GLASS POTS.



(3.) Suppose a glass pot, in the form of the annexed figure, is to be gauged and fixed, the dimensions being as follows: depth, E F, 18·5 inches, mean-diameter, A B = C D, 29·9 inches.

To find the area and content:—

29·9 (diameter) × 29·9 = 894·01 ÷ 11 (circ. div.) = 81·2736 (area) × 18·5 (depth) = 1503·56160 (content.)

Thus entered in the Dimension Book:

| Date when gauged. | Mean-diameter. | Depth. | Diagonal. | Top diameter. | Mouth. |
|---|---|---|---|---|---|
| 1st Jan. 1840. | 29·9 | 18·5 | 35·0 | 30·0 | 08·5 |

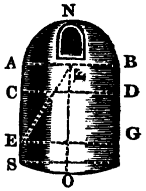
The following is the mode of tabulating the vessel.

| Dry inches. | Content. | | Dry inches. | Content. | | Dry inches. | Content. | |
|---|---|---|---|---|---|---|---|---|
| | lbs. | Decl. parts of a lb. | | lbs. | Decl. parts of a lb. | | lbs. | Decl. parts of a lb. |
| Full | 1503<br>81 | 5616<br>2736 | 7 | 934<br>81 | 6464<br>2736 | 13 | 447<br>81 | 0048<br>2736 |
| 1 | 1422<br>81 | 2880<br>2736 | 8 | 853<br>81 | 3728<br>2736 | 14 | 365<br>81 | 7312<br>2736 |
| 2 | 1341<br>81 | 0144<br>2736 | 9 | 772<br>81 | 0992<br>2736 | 15 | 284<br>81 | 4576<br>2736 |
| 3 | 1259<br>81 | 7408<br>2736 | 10 | 691<br>81 | 8256<br>2736 | 16 | 203<br>81 | 1840<br>2736 |
| 4 | 1178<br>81 | 4672<br>2736 | 11 | 609<br>81 | 5520<br>2736 | 17 | 121<br>81 | 9104<br>2736 |
| 5 | 1097<br>81 | 1936<br>2736 | 12 | 528<br>81 | 2784<br>2736 | 18 | 40<br>40 | 6368<br>6368 |
| 6 | 1015<br>81 | 9200<br>2736 | | | | 18·5 | 00 | 0000 |

pot at one inch deep; and the same area will serve for the area of every inch of the depth. If the form of the pot is not so near to that of a cylinder, take cross-diameters at five, fifteen, and twenty inches from the bottom, and tabulate the areas as before.

---

(4.) Suppose another glass pot to be gauged is of the following dimensions: original depth, 21·6 inches, level depth from the mouth, F O, 20·6; diameters, A B, 27·3, C D, 27·2, E G, 27·1; depth of the mouth, N F, 8·2, and diagonal, F S, 31·1.



The area is found as follows:—

$$\begin{array}{r} 27{\cdot}3 \\ 27{\cdot}2 \\ 27{\cdot}1 \\ \hline 81{\cdot}6 \div 3 = 27{\cdot}2 \times 27{\cdot}2 \div 11 = 67{\cdot}26 \end{array}$$

Thus entered in the Dimension Book.

| | Diameter. | Area. | Depth. |
|---|---|---|---|
| Original depth.... 21 | | | |
| Level depth...... 20·6 | 27·2 | 67·26 | 20·8 |
| 41·6 | | | |
| Mean depth...... 20·8 | Mouth ............ | | 8·2 |

The content of each inch of the depth as entered in the Table Book will be as follows:—

| | | | | | |
|---|---|---|---|---|---|
| Full | 1399·01 | 8 | 860·93 | 15 | 390·11 |
| 1 | 1331·75 | 9 | 793·67 | 16 | 322·85 |
| 2 | 1264·49 | 10 | 726·41 | 17 | 255·59 |
| 3 | 1197·23 | 11 | 659·15 | 18 | 188·33 |
| 4 | 1129·97 | 12 | 591·89 | 19 | 121·07 |
| 5 | 1062·71 | 13 | 524·63 | 20 | 53·81 |
| 6 | 995·45 | 14 | 457·37 | 20·8 | 00·00 |
| 7 | 928·19 | | | | |

A plate glass pot is gauged in the same manner, except that a different circular divisor is used. (See page 173.)

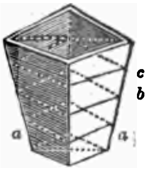
Elliptical glass pots are also gauged in the same manner, the transverse diameter being multiplied by the conjugate, and the square-root of the product taken for a mean-diameter.

TO GAUGE A GUILE TUN VERY NEARLY IN THE FORM OF THE FRUSTUM OF A SQUARE PYRAMID.[*]—Find the depth of the tun, and also the length and breadth at every ten inches. Find the areas at the several breadths and transfer the same with the respective depth to the dimension-book.

TO GAUGE A SPIRIT DEALER'S ELLIPTICAL STORE-CASK.[†]—Measure the internal dimensions and take cross-diameters at every ten inches; calculate the area at each of such distances, and enter the same, with the dimensions, in the dimension-book; multiply each area by the depth for which it is to serve; the sum of the products will be the content of the vessel.

---

[*] EXAMPLE OF A GUILE TUN.



(5.) Let the annexed figure represent a pyramidical guile-tun to be gauged and tabulated; and suppose the depth to be 30 inches; the length of the side *a*, (5 inches from the bottom) = 32·5, and at 15 inches from the bottom, the side, *b*, 38·5; and at 25 inches deep the side *c* = 42·5 inches·

To find the areas :

32·5 × 32·5 ÷ 277·274 = 3·8094 gallons.
38·5 × 38·5 ÷ 277·274 = 5·35 gallons.
42·5 × 42·5 ÷ 277·274 = 6·51 gallons.

These sides and areas are entered in the dimension-book, and from them the vessel may be tabulated as in the former examples.

[†] EXAMPLE OF AN ELLIPTICAL STORE CASK.

(6.) Suppose a spirit dealer's elliptical store-cask to be represented by figure 3, page 121, and that the following are its dimensions: it would be thus entered in the table-book.

Mr. G. W., Brandy Dealer, No. 5 Rum Cask.

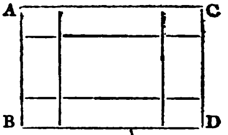
| Depths. | Transverse. | Conjugate. | Areas. | Gallons. |
|---|---|---|---|---|
| 5·6 | 56·5 | 42·6 | 6·820 | 38·19 |
| 10·0 | 57·0 | 43·0 | 6·940 | 69·40 |
| 10·0 | 58·4 | 44·2 | 7·311 | 73·11 |
| 10·0 | 60·0 | 46·0 | 7·818 | 78·18 |
| 10·0 | 62·0 | 46·2 | 8·112 | 81·12 |
| 45·6 | Content of the vessel | | | 340·00 |

**TO GAUGE A MASH TUN OR OTHER NEARLY RECTANGULAR VESSEL.***—With a proper gauging-rule take a diameter in the middle of every ten inches, or less, from the bottom upwards; take also cross-diameters at each of the same levels; find the area of each portion by adding the two lengths and breadths respectively together, and taking half of the sum for the mean length and breadth, and then multiplying such mean length and breadth together, and reducing the same into gallons or bushels, as the case may require. To find the contents of the different parts multiply the area by the depth of the respective part; and add such contents together for the whole content of the vessel.

---

* EXAMPLE OF A MASH TUN.

(7.) Let A B C D represent a horizontal section of a rectangular brewer's mash tun to be gauged and inched, and suppose the lengths and breadths taken according to the rule to be expressed in the second and fourth columns of the following table. The other columns will shew the means, areas, and content.



Memorandum of Mr. A. B.'s Square Mash Tun.

| Divisions. | Lengths. | | Mean lengths. | Breadths. | | Mean breadths. | Area in gallons. | Area in | | | Content in | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Qrs. | B. | Galls. | Qrs. | B. | Galls. |
| 10 | 95·8 | 96·0 | 95·9 | 79·6 | 79·8 | 79·7 | 27·5655 | 0 | 3 | 3·5655 | 4 | 2 | 3·6550 |
| 10 | 96·0 | 96·2 | 96·1 | 80·2 | 80·0 | 80·1 | 27·7618 | 0 | 3 | 3·7618 | 4 | 2 | 5·6180 |
| 10 | 96·0 | 95·7 | 95·8 | 80·4 | 80·2 | 80·3 | 27·7442 | 0 | 3 | 3·7442 | 4 | 2 | 5·4420 |
| 10 | 96·8 | 97·2 | 97·0 | 81·0 | 81·0 | 81·0 | 28·3367 | 0 | 3 | 4·3367 | 4 | 3 | 3·3670 |
| 40 | Content of the whole vessel. …………………… | | | | | | | | | | 17 | 3 | 2·0820 |

If the vessel had been a distillery utensil the last two columns would be unnecessary.

The mode of tabulating this vessel for every inch of its depth is the same as in the former examples, namely, the area of each respective part is added to itself as many times as the section is inches deep; after which the officer's periodical gauge consists in merely ascertaining the depth of liquor or materials in the vessel, and entering from the table the proper quantity corresponding with the actual depth.

**To gauge and fix a rectangular back or cooler.*** —Ascertain the mean length and breadth and find the area in the usual manner. Cause liquor to be admitted to cover the bottom of the cooler, and take dips at different parts of the vessel, according as it is more or less inclined, and then add such dips together and divide by their number for a mean dip. Fix upon a convenient dipping place, and calculate the area to every tenth part of the depth up to the height of three or four inches from the bottom, which insert in the Table Book.

---

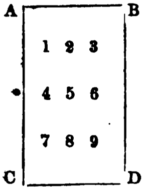
* EXAMPLE OF A RECTANGULAR COOLER.

(8.) Let A B C D be the bottom of a rectangular cooler to be gauged and tenthed, the mean length being 360 inches, and the mean breadth 200 inches; and suppose, on liquor being admitted into the cooler, the following depths are found at the places marked:—

Depth at 1 .. 2·5
2 .. 2·2
3 .. 1·8
4 .. 2·4
5 .. 3·0
6 .. 2·8
7 .. 2·4
8 .. 1·9
9 .. 2·3

Number of dips.... 9 ) 21·3

Mean depth.... 2·3



Suppose the dip at * be now found to be 2·3 inches, it will be the mean, and therefore the proper depth; but if such dip be found to be 2·5 this would be two-tenths of an inch too much, and must be marked on the vessel, or on a post or beam near it, [C, No. 1 — 00·2.] If, instead of this, the dip at * be found to be 2·1, this would be two-tenths too little, and the mark must be [C, No. 1 + 00·2.] "The dips ought to be taken *equidistant* from every extreme to the opposite, and the more irregularity in the make of the vessel, the more dips are requisite."—*Gutteridge's Gauger.*

To tabulate the cooler, we have only to add the area at one-tenth of an inch deep continually to itself for every additional tenth of the depth from the bottom, thus,

25·967 Area at 0·1 inches deep.
25·967

51·934 Area at 0·2 inches deep.

And so on for three or four inches of the depth.

### 3. *Of Irregular Vessels.*

IRREGULAR VESSELS are such as cannot be co veniently reduced to the usual forms of solids, and inclu various large distillery vessels, whose bases approach the elliptical form, and whose sides bulge out either in t middle or otherwise. Under this head may also be clas coppers with rising and falling crowns; vessels fixed very inclined positions, and vessels with internal incu brances.

TO GAUGE AND TABULATE AN IRREGULAR ELLIPTIC VESSEL*.—With a chalk-line divide the bottom of t vessel into quarters, and afterwards draw 7, 9 or any oth odd number of perpendicular ordinates, according to t rules already laid down, (see page 105,) and mark t ends of the ordinates with particular numbers, as 1 2 2, &c.

In order to draw lines from the extremities of the or nates up the sides of the vessel, so that ordinates may taken in any part of its depth at the same equal distanc from each other, as those at the bottom are from ea other, proceed in the following manner:—Hold a chalk plumb-line at the top of the vessel, so that the plumm falls on the ordinate 1 1; then removing the plummet to t extremity 1, while the other end of the line is contin stationary, strike a line against the side of the vessel, fr the bottom to the top; proceed in like manner to stri lines from the extremities of every ordinate, and also the transverse and conjugate diameters, from the bott of the vessel to the top.

If the vessel be intended to be tabulated for dry inch begin to mark out the distances, and take the dimensions from the top, leaving the odd inches and tenths (if any) in the lower distance; but if for wet inches, begin from the bottom, leaving the odd inches and tenths (if any) in the upper distance, except the vessel has a curb or cover, through which the gauges must be taken; in such case, should the vessel be intended to be tabulated for dry inches, the thickness of such curb or cover must be deducted from the upper distance, and the dimensions taken in the middle of the differeuce, as exemplified in the table of dimensions in the margin.

---

* This rule, which is deduced from Mr. Moss's and Mr. Shirtlif rules for measuring by equidistant ordinates, has been published, with following example, at the Government Press, for the use of the officers

If the dimensions of the vessel at the top and bottom do not vary very considerably, they may be taken in the middle of every ten inches; otherwise they should be taken in the middle of every two, four, six or eight inches, according as the sides incline to or recline from a perpendicular direction.

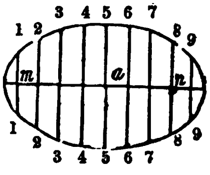
Previous to setting out these distances, the depth of the vessel should be ascertained. Having fixed upon and marked the proper dipping-place, let fall therefrom a plumb-line, and mark the spot on which the plummet falls; carefully measure the distance between such mark and the dipping-place, and this distance will be the true depth of the vessel in the position in which it then stands.

As the lines drawn from the shorter ordinates up the sides of the vessel will be oblique, care must be taken in

---

EXAMPLE OF A DISTILLERY UTENSIL.

Let the annexed figure represent the base of an elliptical vessel, to be gauged and tabulated, and suppose nine equidistant ordinates have been taken on the base, and between the different sections, according to the rule, the dimensions whereof, with the areas, incumbrance, &c. are as follows:



marking the points from which the ordinates in the respective frustums are to be ascertained, that the lines measured from such points cut, at true distances from the top of the vessel, a perpendicular line falling on the respective ordinates at the bottom of the vessel. The distances on the oblique lines may be ascertained as follows:—As the length of the perpendicular line is to the length of the oblique line, so are the respective distances from the top or bottom on the perpendicular line to the respective distances from the top or bottom on the oblique line; or the true distances may be easily ascertained by trial, which is the method generally adopted.

Find the gross area of each frustum as follows:—

---

Mr. A. B.'s Wash Back, Gauged October 10th, 1834, by C. D. E. F. &c.

| Depths | 9 Ordinates, 15 Inches Equidistant. | | | | | | | | | | | Incumbrance. | Gross Area | Net Area | Content in Gallons. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transverse | 1 | 2 | 3 | 4 | Conjugate 5 | 6 | 7 | 8 | 9 | Sum of Segments. | | | | |
| 01·7 | Curb | or C | over | | | | | | | | | | | | |
| 08·3 | 124·0 | 19·4 | 54·0 | 69·0 | 76·4 | 78·0 | 76·3 | 68·8 | 53·7 | 19·6 | 04·0 | See below. | 27·4565<br>.. | 25·6966<br>27·4565 | 102·78<br>118·06 |
| 10·0 | 126·1 | 24·7 | 55·8 | 70·0 | 78·5 | 80·0 | 78·2 | 70·5 | 55·9 | 24·8 | 06·1 | | 28.5679 | .. | 285·67 |
| 10·0 | 128·3 | 29·2 | 58·3 | 71·7 | 79·3 | 81·6 | 79·1 | 71·8 | 58·1 | 29·2 | 08·3 | | 29.5757 | .. | 295·75 |
| 10·0 | 130·2 | 31·9 | 59·8 | 73·3 | 80·4 | 82·8 | 80·5 | 73·5 | 59·8 | 31·7 | 10 2 | | 30.4400 | .. | 304·40 |
| 10·0 | 132·2 | 35·7 | 61·5 | 74·7 | 81·9 | 84·0 | 82·0 | 74·6 | 61·3 | 35·9 | 12·2 | | 31.4352 | .. | 314·35 |
| 09·2 | 134·0 | 40·8 | 62·7 | 76·3 | 82·9 | 85·2 | 83·0 | 76·1 | 62·8 | 41·0 | 14·0 | | 32.4398 | .. | 298·44 |
| 01·1 | Drip per Measure.......... | | | | | | | | | | | | | | 24·00 |
| 60·3 | Gross Depth. | | | | | | | | | | | | | Content. | 1742·48 |

**Incumbrance.**—A Beam inside the Top.

| | | |
|---|---|---|
| L | 122·0 | Inches, Area 1·7599 Gallons, to be deducted from the Area of the first four Inches from the Top |
| B | 04·0 | |
| D | 04·0 | |

The vessel is here supposed to require twenty-four gallons of liquor to cover the bottom, and the depth of such liquor perpendicularly under the dipping place is supposed to be 01·1 inches.

The mode of finding the foregoing areas, according to the rule laid down in the text and in page 109, is shewn in the following:—

To the sum of the first and last, or the two extreme ordinates, add four times the sum of the second, fourth, sixth and eighth, or even ordinates, and also double the sum of the rest; multiply this total by the equidistance between the ordinates, and to the product add the product of the sum of the extreme ordinates, multiplied by the sum of segments; this sum, divided by 831·822 (three times

---

*Scheme of Operations of finding the Areas of the several Frustums.*

| | FRUSTUMS. | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Ext. Ordinates of the Frustums | 19·4<br>19·6 | 24·8<br>24·7 | 29·2<br>29·2 | 31·9<br>31·7 | 35·7<br>35·9 |
| | 39·0 | 49·5 | 58·4 | 63·6 | 71·6 |
| Sum of Segments | 4· | 6·1 | 8·3 | 10·2 | 12·2 |
| Ext. Ordinates × by Sum of Segments | 156· | 301·95 | 484·72 | 648·72 | 873·5 |
| Second, fourth, sixth, and eighth, or even Ordinates | 54·0<br>76·4<br>76·3<br>53·7 | 55·8<br>78·5<br>78·2<br>55·9 | 58·3<br>79·3<br>79·1<br>58·1 | 59·8<br>80·4<br>80·5<br>59·8 | 61·5<br>81·9<br>82·0<br>61·3 |
| | 260·4<br>4 | 268·4<br>4 | 274·8<br>4 | 280·5<br>4 | 286·7<br>4 |
| Even Ordinates × by 4 | 1041·6 | 1073·6 | 1099·2 | 1122·0 | 1146·8 |
| Third, fifth, and seventh, or odd Ordinates, exclusive of the ext. Ordinates | 69·0<br>78·0<br>68·8 | 70·0<br>80·0<br>70·5 | 71·7<br>81·6<br>71·8 | 73·3<br>82·8<br>73·5 | 74·7<br>84·0<br>74·6 |
| | 215·8<br>2 | 220·5<br>2 | 225·1<br>2 | 229·6<br>2 | 233·3<br>2 |
| Odd Or. (exclusive of ext. Or.) × by 2 | 431·6 | 441·0 | 450·2 | 459·2 | 466·6 |
| Even Ordinates × by 4 | 1041·6 | 1073·6 | 1099·2 | 1122·0 | 1146·8 |
| Sum of the extreme Ordinates | 39·0 | 49·5 | 58·4 | 63·6 | 71·6 |
| Sum | 1512·2 | 1564.1 | 1607·8 | 1644·8 | 1685·0 |
| Equidistance between the Ordinates | 15 | 15 | 15 | 15 | 15 |
| Product | 22683·0 | 23461·5 | 24117·0 | 24672·0 | 25275· |
| Extreme Ordinates × by Sum of Seg. | 156·0 | 301·95 | 484·72 | 648·72 | 873·5 |
| Divided by 831·822 | 22839 0 | 23763·45 | 24601·72 | 25320·72 | 26148·5 |
| Areas of the Frustums | 27·4565 | 28·5679 | 29·5757 | 30·4400 | 31·435 |

The Number designated the Sum of Segments, is the difference between the whole length of the Transverse Diameter and that Part of it enclosed between the two Extreme Ordinates; or in other words, it is the sum of the versed sines of the Elliptical Segments cut off by the extreme Ordinates (marked in the Figure 1, 1, and 99.) These Segments approaching very nearly to the form of parabolas, are considered as such; and as every parabola is ⅔ of its circumscribing parallelogram, the sum of the extreme the cubic inches in an imperial gallon) will give the area of the elliptical curve.

Deduct the area of the incumbrance (if any) from the area affected by such incumbrance, and the difference will be the net area, which, multiplied by that part of the depth to which it belongs, will give the content of the frustum corresponding to such dimensions; proceed in like manner for the content of the other frustums; add the whole of

---

**Ordinates multiplied by the sum of Segments, and the product divided by three times the cubic inches in an Imperial Gallon, gives the same result as dividing two-thirds of the product of each extreme Ordinate and its versed sine, by the cubic inches in an Imperial Gallon, and is performed with more ease and expedition.**

**The curb or cover being 01·7 inches thick, and the gauges requiring to be taken from the top thereof, the table, instead of beginning at full, must begin 01·7 inches above the upper part of the inside the vessel, as follows:—**

METHOD OF TABULATION.

| Dry Inches. | |
|---|---|
| Full 01·7 | 1743·4834 |
| $\frac{3}{10}$ upper area | 7·7090 |
| 2 | 1735·7744 |
| | 25·6966 |
| 3 | 1710·0778 |
| 4 | 1684·3812 |
| | 25·6966 |
| 5 | 1658·6846 |
| $\frac{7}{10}$ 1st area<br>$\frac{3}{10}$ 2d area | 26·2245 |
| 6 | 1632·4601 |
| | 27·4565 |
| 7 | 1605.0036 |
| 8 | 1577·5471 |
| | 27·4565 |
| 9 | 1550·0906 |
| 10 | 1522·6341 |
| | 28·5679 |
| 11 | 1494·0662 |
| 12 | 1465·4983 |
| | 28·5679 |
| 13 | 1436·9304 |
| 14 | 1408·3625 |
| | 28·5679 |
| 15 | 1379·7946 |
| 16 | 1351·2267 |
| | 28·5679 |
| 17 | 1322·6588 |
| 18 | 1294·0909 |
| | 28·5679 |
| 19 | 1265·5230 |
| 20 | 1236·9551 |
| | 29·5757 |
| 21 | 1207·3794 |
| 22 | 1177·8037 |
| | 29·5757 |
| 23 | 1148·2280 |
| 24 | 1118·6523 |
| | 29·5757 |
| 25 | 1089·0766 |
| 26 | 1059·5009 |
| | 29·5757 |
| 27 | 1029·9252 |
| 28 | 1000·3495 |
| | 29·5757 |
| 29 | 970·7738 |
| 30 | 941·1981 |
| | 30·4400 |
| 31 | 910·7581 |
| 32 | 880·3181 |
| | 30·4400 |
| 33 | 849·8781 |
| 34 | 819·4381 |
| | 30·4400 |
| 35 | 788·9981 |
| 36 | 758·5581 |
| | 30·4400 |
| 37 | 728·1181 |
| 38 | 697·6781 |
| | 30·4400 |
| 39 | 667·2381 |
| 40 | 636·7981 |
| | 31·4352 |
| 41 | 605·3629 |
| 42 | 573·9277 |
| | 31·4352 |
| 43 | 542·4925 |
| 44 | 511·0573 |
| | 31·4352 |
| 45 | 479·6221 |
| 46 | 448·1869 |
| | 31·4352 |
| 47 | 416·7517 |
| 48 | 385·3165 |
| | 31·4352 |
| 49 | 353·8813 |
| 50 | 322·4461 |
| | 32·4398 |
| 51 | 290·0063 |
| 52 | 257·5665 |
| | 32·4398 |
| 53 | 225·1267 |
| 54 | 192·6869 |
| | 32·4398 |
| 55 | 160·2471 |
| 56 | 127·8073 |
| | 32·4398 |
| 57 | 95·3675 |
| 58 | 62.9277 |
| | 32·4398 |
| 59 | 30·4879 |
| $\frac{2}{10}$ lower area | 6·4879 |
| 59·2 | 24·0000 Drip. |

the contents together, and also the quantity of liquor necessary to cover the bottom, and the total will be the whole content of the vessel.

Ascertain the quantity of liquor required to cover the bottom, by measuring into the vessel, with a known measure, a sufficient quantity to completely cover the bottom in every part; carefully ascertain the depth of the liquor perpendicularly under the fixed dipping-place, subtract the depth thus found, and also the thickness of the curb or cover, (when the dry inches are to be taken above it,) from the gross depth of the vessel, ascertained as before di-

*Table of the Vessel, as entered in the Table Book.*

| Dry Inches. | Gallons. | Area of a Tenth. | Dry Inches. | Gallons. | Area of a Tenth | Dry Inches. | Gallons. | Area of a Tenth | Dry Inches. | Gallons. | Area of a Tenth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01·7 | 1743 | | 16 | 1351 | | 31 | 911 | | 46 | 448 | |
| 2 | 1736 | | 17 | 1323 | | 32 | 880 | | 47 | 417 | |
| 3 | 1710 | 2·569 | 18 | 1294 | | 33 | 850 | | 48 | 385 | |
| 4 | 1684 | | 19 | 1265 | | 34 | 819 | | 49 | 354 | |
| 5 | 1659 | $\frac{7}{10}$2·569 | 20 | 1237 | | 35 | 789 | 3·044 | 50 | 322 | |
| 6 | 1632 | $\frac{3}{10}$2·745 | 21 | 1207 | | 36 | 758 | | 51 | 290 | |
| | | | 22 | 1178 | | 37 | 728 | | 52 | 257 | |
| 7 | 1605 | | 23 | 1148 | | 38 | 698 | | 53 | 225 | |
| 8 | 1577 | 2·745 | 24 | 1119 | | 39 | 667 | | 54 | 193 | |
| 9 | 1550 | | 25 | 1089 | 2·957 | 40 | 637 | | 55 | 160 | 3·243 |
| 10 | 1523 | | 26 | 1059 | | 41 | 605 | | 56 | 128 | |
| 11 | 1494 | | 27 | 1030 | | 42 | 574 | | 57 | 95 | |
| 12 | 1465 | | 28 | 1000 | | 43 | 542 | | 58 | 63 | |
| 13 | 1437 | | 29 | 971 | | 44 | 511 | | 59 | 30 | |
| 14 | 1408 | | 30 | 941 | | 45 | 480 | 3·143 | 59·2 | 24 | Drip |
| 15 | 1380 | 2·856 | | | | | | | | | |

In dividing the table-book, a sufficient space should be appropriated for entering the dimensions of the whole of the utensils (and for such others as may be erected) before the commencement of the tables, shewing the quantity of liquor each vessel is capable of containing at every inch of its depth.

Had the vessel been gauged and tabulated for wet inches, the dimensions must have been taken in the middle of the respective distances, commencing from the bottom of the vessel, as set forth in the margin, disregarding the curb or cover, and deducting the area of the incumbrance from that part of the area of the frustum affected by such incumbrance.

Depths
08·6
10·0
10·0
10·0
10·0
08·9
01·1 Drip.
58·6 Gross depth.

rected, and the remainder will be the net depth to be tabulated.

TO GAUGE A COPPER WITH A RISING CROWN.*—Lay a straight pole or rod diametrically across the mouth of the copper, or where that cannot conveniently be done extend a small cord like a diameter across the mouth, causing it to be held tight in that situation. Then, along this cord or rod, move a line furnished with a plummet, till the head hangs directly over the centre of the crown, and with a dimension-cane take the particular distance between the centre of the crown and the cord at the level of the mouth; this distance will be the depth of the copper in the middle.

Slide the plumb-line along the rod or cord above, until the plummet hangs freely over the lowest part of the bottom of the copper, just at the beginning of the convexity of the crown, where it rises from the sides; and with a rule or dimension-cane, take the length of this perpendicular also; then, without shifting the line, measure the distance it has been moved from the level of the cord or rod since the first perpendicular was taken. Twice this distance will be the diameter of the base of the spherical segment forming the crown, and the difference of the two perpendiculars will, evidently, be the altitude of the segment, or *rise of the crown.*

---

* "Coppers used by common brewers have generally bottoms somewhat resembling the segment of a sphere. When the convex projects upwards, the copper is said to have a *rising crown;* but when it projects downwards, leaving a concave space within it, it is denominated a *falling crown.* Coppers with horizontal bottoms are seldom met with; and it may be remarked that small coppers have generally falling crowns, while those of pretty large dimensions are commonly made with rising crowns. To the mouth of some coppers is attached a copper hoop, called a curb; the curb rises several inches above the top of the copper, and is generally of a considerably greater diameter; consequently, it is necessary to take its dimensions as a distinct part of the copper."—*Nisbett and Little's Gauging.*

If the copper has neither a rising nor a falling crown, it may be gauged

Quarter the copper at the bottom and also at the top, by finding the inscribed square in each case, as before directed with respect to a circular vessel; then, in order to draw four chalk lines up the sides of the copper, so that it may be every where truly quartered, proceed thus:—Stick about an inch of lighted candle on the centre of the crown, and let the vessel be darkened at the top; then a line being extended from the top to the bottom, will form a shadow on the side of the copper, which may be traced with a piece of chalk; proceed in the same way for the other three lines.

Take cross diameters in the middle of every four, six, eight, or ten inches, according as the copper differs more or less from a cylindrical form, and find their respective areas, which, multiplied by their corresponding depths, will give their contents as cylinders, the sum of which, added to the quantity of liquor to cover the crown, will give the content of the body of the copper.

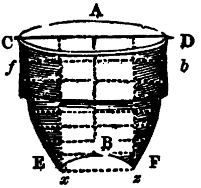
---

by taking cross diameters in the manner already pointed out as to vessels, the form of which is very nearly cylindrical. (See ante page, 191.)

EXAMPLE OF A COPPER WITH A RISING CROWN.

(2.) Suppose the annexed figure to represent a copper with a rising crown to be gauged and inched; the dimensions taken according to the rule to be as follows.—

| Inches | | | | |
|---|---|---|---|---|
| 12 | ( 6 from the top) | 74·5 | 73·7 | 74.1 |
| 10 | (17 .... ) | 74·1 | 73·9 | 74·0 |
| 8 | (26 .... ) | 69·0 | 68·6 | 68·8 |
| 6 | (33 .... ) | 65·0 | 65·0 | 65·0 |
| 6 | (39 .... ) | 61·1 | 60·7 | 60·9 |
| 6 | (45 .... ) | 56·8 | 56·7 | 56·7 |
| — | To cover the crown.. | | | 22 gallons. |
| 48 | | | | |



The most expeditious and certain way of obtaining the quantity of liquor to cover the crown is by letting water into the copper until the crown is exactly covered, and then drawing it off very carefully into some known vessel; but if this be impracticable or undesirable, the content may be found by calculating the content of the frustum, *x* E F *z* *x*, and subtracting the content of the segment, *x* B *z* *x*, from it. (See page 214).

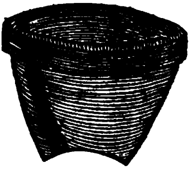
To GAUGE A COPPER WITH A FALLING CROWN.—By the help of a plumb-line find the perpendicular depth of the copper from the top diameter to the angle where the body of the copper and its top are united; this will give the depth, which requires to be tabulated by means of cross diameters taken in the manner directed by the foregoing rule. Find the content of the bottom of the copper either by actual admeasurement or as a spherical segment,* and add such content to the contents of the several sections of the copper for the content of the whole vessel; then tabulate the same in the manner directed in respect of a copper with a rising crown.

---

If the copper be a brewery utensil the contents must be found in barrels, firkins and gallons; such contents being the products of the respective areas multiplied by the parts of the depth set opposite to each, and these, when added together with the quantity to cover the crown, give the whole content of the copper.

The whole content being found, the next business is to find the quantity of wort, &c., at any part of the depth, by taking the dry inches; for which purpose it is necessary to form a table showing the quantity at every inch.

Such a table may be formed by setting down the whole content in barrels, firkins, and gallons, with the decimal parts, and subtracting therefrom, the area at the top, reduced to the same denomination; the remainder gives the quantity in the copper when the surface of the wort, &c. is one inch below the top. A similar operation for every other inch of the depth will complete the table. See page 215.



(3.) Let the annexed figure represent a copper with a *rising crown* and a *curb* to be gauged and inched. The dimensions are taken and the calculations made as in the last example, with this difference only, that the first pair of cross diameters are made in the middle of the *curb*, if its depth be an integral number of inches. If, however, the depth of the curb consists of inches and tenths, the tenths must be considered as belonging to the second division, and must be measured as part of its perpendicular breadth; consequently, the odd tenths that may be in the whole depth of the copper will fall at the bottom, as they always should, when the tabulation is intended for dry inches.—*Nisbett and Little's Gauging*, 147.

* The mode of inching a spherical segment is explained in page 214.

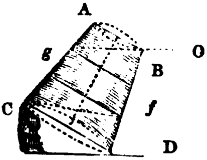
To GAUGE A VESSEL WITH A DRIP OR FALL.—Find the content of the vessel, supposing it to be full and standing upright, according to the foregoing rules; then ascertain the content of the part which will not hold liquor, by reason of the inclining position of the vessel, subtract the one content from the other for the content of the vessel in the inclined position.*

---

* EXAMPLE OF A TUN WITH A FALL OR DRIP.

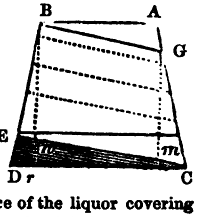
(4.) Suppose a conical tun is posited as in the annexed figure, and its dimensions as follows: top diameter A B 90; bottom diameter C D 106; depth, 60; and slanting side A C or B D 60·93.

The contents of the whole tun will be found by the rule in page 129.



If the vessel be filled until it touches the top diameter at the edge B, it is evident that the part A g B will be empty; and the content of this part, being an ungula or hoof, may be found by the rule in page 125, and this content being deducted from the content of the whole vessel, will give the content of the vessel when full, in the inclined position.

In order to find the content of the ungula, it will be necessary to ascertain the depth A *g*, which may be done when the vessel is filled up to B, by measuring from A to the liquor at *g*. If the vessel be empty, the point *g*, i. e. where the surface of the liquor would cut it, if the vessel were filled up to B, may be found by means of a quadrant; for looking through the sight at O, and the thread falling at the first degree in the limb, the sight will be directed to *g*, which may be marked with chalk.—*Leadbetter's Gauging* 125. See also Dougarthy's Gauger, (1739).



The usual method of gauging a vessel of this description is to pour water into the vessel from a known measure until the bottom is just covered; then let fall a plumb line from B to the surface of the water at *n*; which will give the perpendicular depth of the part G B C E; which is tabulated by means of cross diameters, taken according to the rules already given, (see page 188). It is evident, however, that the sections thus taken, parallel to the horizontal surface of the liquor covering the bottom, will not be circles but ellipses; but as the difference of their diameters will always be small, half the sum of their cross diameters are taken for a mean diameter, and they are then considered as reduced to circles, and the areas found accordingly.

In tabulating a vessel of this description, the chief difficulty is in regu-

TO GAUGE AND TABULATE A VESSEL WHEN INCUMBRANCES ARE TO BE DEDUCTED.*—Find the gross content of the vessel, and also of each incumbrance separately; deduct the whole of the incumbrances from the gross content of the vessel, and the remainder will be the net content of the vessel. In tabulating the vessel deduct the

---

lating the dipping-place. Whether for wet or dry inches, however, it may be most conveniently fixed at the top of the tun, in which case the gauging rod, in taking the depth, will descend in the perpendicular direction B *n*, coming in contact with the bottom of the vessel at *r*.

* EXAMPLE OF A VESSEL WITH INCUMBRANCES.

(5) Suppose the mean length of a vessel (in the form of a regular Parallelopipedon) to be 184·6, the mean breadth 104·4 inches, and the depth and dimensions of the incumbrances as below; required the net content and mode of tabulating the same for the dry inch gauge.

| | Inch. | Gal. |
|---|---|---|
| Gross depth | 80·6 | |
| Drip | 2·8 | 105 |
| Net depth | 77·8 | |

Bottom of the cross bar or beam, from the bottom of the back 69·5
Length 99·5....Breadth 3·8....Depth 4·8
Bottom of second cross bar from the bottom 30·8
Length 99·5....Breadth 3·6....Depth 3·4
Two perpendicular planks, length of each, beginning at the bottom 71·5
Covered with water in the drip 2·0
Net length of each plank 69·5....Breadth 12·5....Thickness 2·5

The content of the vessel is found by multiplying the length, breadth, and depth together, and dividing by 277·274, (see page 116). The content of each incumbrance is found in the same manner, and when added together, and taken from the gross content of the vessel, the remainder shews the net content.

In order to tabulate the vessel, the following method must be adopted.

| | |
|---|---|
| Net depth of the vessel | 77·8 |
| Net depth of the planks | 69·5 |
| Top of the planks from the top of the bars | 8·3 |

If the depth of either of the cross bars be added to the distance of its bottom from the bottom of the vessel, and that sum subtracted from the gross depth, the remainder will be the distance of the top of such cross bar from the top of the vessel. The distance of the top of the first cross bar from the top of the vessel, is therefore 6·3, and the distance of the second is 46·4 inches. These particulars, with the several areas, may be formed into a preparatory table, in order that the incumbrances may be deducted in their proper place, when the vessel is tabulated for dry inches.

respective parts of each incumbrance applicable to the particular section of the vessel to be tabulated for the net quantity at any given depth of the vacuity of the vessel.

| Names of the several particulars inserted. | Dimensions. | Areas of the Incumbrances | Gross Area. | Net Area. | Depth<br>Inches | Content in Gallons. |
|---|---|---|---|---|---|---|
| Mean length.... | 184·6 | .. | 69·506 | 69·506 | 06·3 | 437·8878 |
| Mean breadth .. | 104·4 | | | | | |
| Gross area ...... | .. | .. | 69·506 | 68·143 | 02·0 | 136·2860 |
| First cross bar.. | .. | 1·363 | 1·363 | | | |
| Gross area...... | .. | .. | 69·506 | 67·919 | 02·8 | 190·1732 |
| First cross bar.. | .. | 1·363 | 1·587 | | | |
| Planks ......... | .. | ·224 | | | | |
| Gross Area. .... | .. | .. | 69·506 | 69·282 | 35·3 | 2445·6546 |
| Planks ......... | .. | ·224 | ·224 | | | |
| Gross Area. .... | .. | .. | 69·506 | 67·991 | 03·4 | 231·1694 |
| Second cross bar | .. | 1·291 | 1·515 | | | |
| Planks ......... | .. | ·224 | | | | |
| Gross area...... | .. | .. | 69·506 | 69·282 | 28·0 | 1939·8960 |
| Planks ......... | .. | ·224 | ·224 | | | |
| Drip | .. | .. | .. | .. | 02·8 | 105· |
| Whole Depth, &c. | | | | | 80·6 | 5486·0670 |

The preceding work may be formed into a table of dry inches, as follows:

| Dry Inches. | | Dry Inches. | | Dry Inches. | |
|---|---|---|---|---|---|
| Full | 5486·067 | 9· .. | 4864·3499 | 47· .. | 2235·2708 |
| | 69·506 | | 67·9190 | | 67·9910 |
| 1· .. | 5416·561 | 10· .. | 4796·4309 | 48· .. | 2167·2798 |
| 6· .. | 5069·031 | | 67·9190 | | 67·9910 |
| ·3 .. | 20·8518 | 11· .. | 4728·5119 | 49· .. | 2099·2888 |
| 6·3 .. | 5048·1792 | ·1 .. | 6·7919 | ·8 .. | 54·3928 |
| ·7 .. | 47·7001 | 11·1 .. | 4721·7200 | 49·8 .. | 2044·8960 |
| 7· .. | 5000·4791 | ·9 .. | 62·3538 | ·2 .. | 13·8564 |
| | 68·1430 | 12· .. | 4759·3662 | 50· .. | 2031·0396 |
| | | | 69·2820 | | 69·2820 |
| 8· .. | 4932·3361 | 46· .. | 2303·7782 | 77· .. | 160·4256 |
| ·3 .. | 20·4429 | ·4 .. | 27·7128 | ·8 .. | 55·4256 |
| 8·3 .. | 4911·8932 | 46·4 .. | 2276·0654 | 77·8 or Drip. | 105· |
| ·7 .. | 47 5433 | ·6 .. | 40·7946 | | |

The foregoing table is constructed to show the quantities at 06·3, 08·3, 11·1, 46·4, and 49·8 dry inches, so as to take up, distinctly, each section into which the utensil is necessarily divided in gauging the same; the even inches, from 2 to 5, and from 12 to 45, and from 51 to 76, which are calculated upon the same principle as the tabulation in page 215, are omitted for the sake of conciseness.

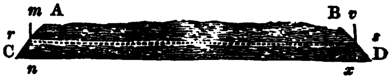
The entry in the dimension book will consist of the area, at each inch of the depth. See page 216, &c.

TO GAUGE AN IRREGULAR MALT FLOOR.—If one or both of the ends or sides be slanting, take the length or breadth, not at the bottom or top, but through the middle of the slant or slants.* Obtain a mean of the depth, and find the content as directed by the former rules. If there be any other irregularity in the form of the floor, it must be divided into parallelograms, or other regular forms, and the contents of each part found separately, and added together for the whole content.

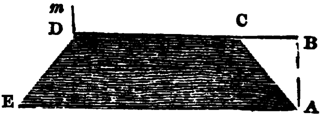
---

* EXAMPLES OF AN IRREGULAR MALT FLOOR.

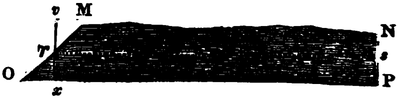
(6.) Let A B C D be the end of a piece of malt with slanting sides, to be measured.



Half way between A and C let a rule as *m n* be set up perpendicularly, and another as *v x*, perpendicularly, half way between B and D. Then extend a tape from *r* to *s*, or from *m* to *v*, parallel to *r s*, regarding *r s* as the breadth of the floor. In like manner the lengths must be taken if the ends be slanting. Then from ten or more dips with a gauging rod and brass plate deduce a mean breadth, and calculate the contents as directed in p 183.—*Iley's Gauging.* Or, fix the tape at the innermost sloping edge of one end (as D) by putting your dipping piece through the ring; then extend the tape in a horizontal direction, D B, to the outermost sloping edge of the opposite end of the floor, which may be found by dropping a few grains of corn, and you will then have one length of the floor; for what is lost in the length at one end will be gained at the other. In other respects proceed as before.—*Nisbett's Gauging.*



(7.) Let M N O P be the ends of a piece of malt, having one side slanting, and the other against a perpendicular wall.



Set up a rule at one end perpendicularly, half way between M and O, and extend the tape from *r* to *s*, and proceed in other respects as in the former example.

TO GAUGE A SHIP.—When the vessel is dry, measure the length on a straight line along the rabbit of the keel of the ship, from the back of the main stern post to a perpendicular line, let fall from the fore part of the main stem under the bowsprit; from this length subtract $\frac{3}{5}$ of the extreme breadth, and the remainder will be the length of the keel for tonnage. When the ship is afloat, let fall a plumb line over the stern of the ship, and measure the distance between this line and the aft part of the stern post at the load-water mark; then measure from the top of the plumb line in a parallel direction with the water, to a perpendicular point immediately over the load water-mark at the fore part of the main stem; from the last measured distance subtract the former, and the remainder will be the ship's extreme length. From this length deduct 3 inches for every foot of the load-draught of water for the rake abaft, and also $\frac{3}{5}$ of the ship's extreme breadth for the rake of the stem, and the remainder will be the true length of the keel for tonnage. To find the breadth, whether the vessel be dry or afloat, measure from outside to outside of the plank, in the broadest part of the ship, whether above or below the main wales, exclusive of all manner of doubling planks or sheathing, that may be wrought upon the sides of the vessel. Then multiply the length of the keel, in feet, by the breadth, and this product by half the breadth; divide the last product by 94, and the quotient will be the tonnage of the vessel.*

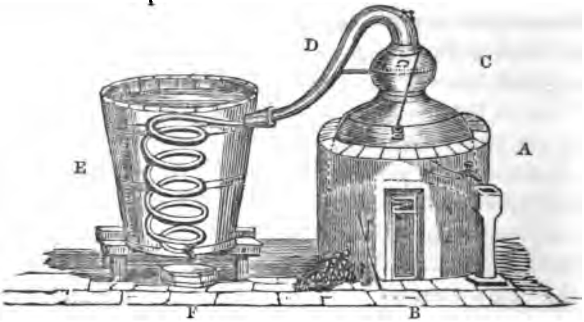
---

* Some writers on this subject divide by 100 instead of 94 for king's ships. On the same principle the divisor for merchant's ships should be decreased perhaps to 90 or 92.—*Nisbett's Gauging.*

But the most correct mode of gauging a ship is by *displacement*. See the report of the House of Commons on Shipwrecks, 1836. Divide the cubic feet which a ship displaces in sinking from the *light* water-mark to the *load* water-mark, by 35; the quotient is the vessel's true burthen.—*Nisbett's Gauging.*

## 4. *Of Stills.*

STILLS are of different forms, but the principle upon which they are all constructed, may be understood by the following figure, which represents a still of the old and common description.



A is the body of the still, or the copper in which the wash is boiled for distillation; B is the furnace for heating the liquor; C is the still head; D is the worm through which the spirit escapes in vapour, and E is the worm tub, or refrigerator; and F the receiver. The parts of a still which require to be gauged, are the body and head. The body is (in the old form of still) frequently in the form of a round copper with a rising crown, and with a globular dome or top. The head is a compound figure.

TO GAUGE THE BODY OF A STILL.*—Take the true distance from the centre of the crown, to the centre of the top

---

* EXAMPLE OF THE BODY OF A STILL.

(1.) Let the above figure A represent the body of a still to be gauged and tabulated; and suppose the dimensions taken according to the above rule to be expressed, together with the areas and content, in the following table; and that there are incumbrances to be deducted: viz.

A Round Spindle, length 42·5 inches. diameter 02·0, area ·0113 gallon, to be taken from every part of the depth, except the bottom inch.

One Cross Bar, length 107·0 inches, breadth 01·5. depth 03·0, area ·4630 gallon, to be taken from the 26th, 27th, and 28th inches from the crown.

Two Cross Bars each, length 90·0 inches, breadth 02·0, depth 00·6, area of the globular part, and the internal depth (exclusive of the rising crown) will be obtained. From each part, where the globular part commences, extend a line as a diameter, and measure the distance from such line to the top of the rising crown; which distance, taken from the whole part, leaves the altitude of the globular part. Quarter the still at the bottom and at the diameter where the globular part commences, and take cross diameters in the

---

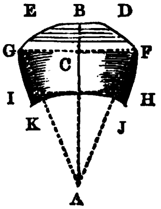
1·2983 gallons, to be deducted from the lower six-tenths of the fourth inch from the Crown.

Four upright Bars each, length 21·0 inches, breadth 02·0, depth 00·6, area ·0173 gallon, to be deducted from the lower twenty-one inches.

All the other Incumbrances, such as Sweeps, Chains, &c. immersed in the liquor, required to cover the crown.

Mr. A. B.'s Wash Still, gauged October 11, 1834, by C. D. E. F. and G. H.

| Depths. | Cross diameters | | Mean Diameters. | Incumbrance. | | Gross Area. | Net Area. | Content in gallons. |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | | Depths | Area. | | | |
| 15·0 | 30·7<br>104·1 | 30·7<br>104·1 | 30·7<br>104·1 | 15·0 | ·0113 | Globular | — | 256·4710 |
| 08·5 | 107·8 | 106·4 | 107·1 | 00·5 | ·0113 | 32·4907 | 32·4794 | 16·2397 |
| | | | | 03·0 | ·4743 | | 32·0164 | 96·0492 |
| | | | | 04·0 | ·0113 | | 32·4794 | 129·9176 |
| | | | | 01·0 | ·0286 | | 32.4621 | 32·4621 |
| 10·0 | 102·6 | 103·4 | 103·0 | 10·0 | ·0286 | 30·0507 | 30·0221 | 300·2210 |
| 10·0 | 92·6 | 92·0 | 92·3 | 06·4 | ·0286 | 24·1314 | 24·1028 | 154·2579 |
| | | | | 00·6 | 1·3269 | | 22·8045 | 13·6827 |
| | | | | 02·0 | ·0286 | | 24·1028 | 48·2056 |
| | | | | 01·0 | ·0173 | | 24·1141 | 24·1141 |
| | | | | Crown per Measure.............. | | | | 77·0000 |
| 43·5 | Depth | | | | | | Content.. | 1148·6209 |



Let D E F G represent the globular part of the still.

From the square of half the bottom or greater diameter F G, subtract the sum of the squares of half the top diameter D E, and the altitude of the frustum B C; divide the remainder by twice the said altitude, and the quotient will be the distance (C A) of the greater diameter from the centre of the sphere; the square of which, added to the square of half the greater diameter, gives the square of G A, the semi-diameter of the sphere.

middle of every 6, 8, or 10 inches, in manner directed for gauging a copper with a rising crown. Find the areas of the respective parts, and multiply the same by their corresponding depths, for their contents as cylinders; which contents added together, and to the contents of the globular part, and the quantity of liquor required to cover the rising crown, will give the content of the body of the still.

---

The square of the semi-diameter being obtained, the segment is inched as follows.

To twice the difference of the squares of the semi-diameter G A, and the distance A B diminished one inch, add half the square of the less diameter D E; to this sum add two thirds of the square of the altitude *m* B, that is, ·6666; this last sum multiplied by ·00283257, gives the content of the first inch in imperial gallons.

From the square of the semi-diameter G A subtract the square of A B diminished two inches, and from twice the remainder, take half the square of the top diameter D E; multiply the remainder by ·00283257, and add the product to the quantity contained in the first inch, the sum will be the content of the second inch.

Let the product last mentioned be reserved, from which take ·02266056, reserving the difference, which add to the quantity contained on the second inch, the sum will be the quantity contained on the third inch. From the reserved difference take ·02266056, add the remainder to the third inch; the sum gives the quantity upon the fourth inch; and in like manner proceed to find the quantity upon every inch of the globular part, thus:—

$15{\cdot}35^2 = 235{\cdot}6225$; $15^2 = 225$, and $52{\cdot}05^2 = 2709{\cdot}2025 - (235{\cdot}6225 + 225) = 2709\ 2025 - 460{\cdot}6225 = 2248{\cdot}58 \div 30 = 74{\cdot}95266$ (= A C) $+ 15 = 89{\cdot}95266$ (= A B;) then C $G^2$ (= $2709{\cdot}2025$) + C $A^2$ (= $5617{\cdot}9012$) = $8327{\cdot}1037$ = A $G^2$; then $8327{\cdot}1037$ (= A $G^2$) $- 7912{\cdot}5757$ (= A $m^2$) $= 414{\cdot}528 \times 2 = 829{\cdot}056 + 471{\cdot}245$ (= $\frac{1}{2}$ of D $E^2$) $= 1300{\cdot}301 + {\cdot}6666$ (= $\frac{2}{3}$ of B $m^2$) $= 1300{\cdot}9676 \times {\cdot}00283257 = 3{\cdot}68508179$ Content of first inch. Also $8327{\cdot}1037$ (= A $G^2$) $- 7735{\cdot}6704$ (= A $n^2$) $= 591{\cdot}4333 \times 2 = 1182{\cdot}8666 - 471{\cdot}245$ (= $\frac{1}{2}$ D $E^2$) $= 711{\cdot}6216 \times {\cdot}00283257 = 2{\cdot}01571799$ = reserved product to be added to the first inch; then say

| | | | | Area of Incumbrance | Net Content |
|---|---|---|---|---|---|
| Reserved Product add to 1st Inch | 2·0157 | Content of 1st Inch | 3·6850 | ·0113 | 3·6737 |
| Subtract | ·0226 | Add | 2·0157 | | |
| Add to 2nd Inch | 1·9931 | 2nd Inch | 5·7007 | .. | 5·6894 |
| | ·0226 | | 1·9931 | | |
| Add to 3rd Inch | 1·9705 | 3rd Inch | 7·6938 | .. | 7·6825 |
| The operation is continued in this way to the 15th Inch, which is.......... | | | 29·8482 | .. | 29·8369 |
| Content of the Globular Part...... | | | | | 256·4710 |

TO GAUGE THE BODY OF A SMALL STILL.—When the still is too small to admit a person getting inside thereof to take the internal dimensions, the most eligible method of ascertaining the content of the body, is by filling it with water from a known measure.

To find how much the still will contain, at every dry inch from the gauging or dipping-place, proceed as follows :—After having filled it with water to such dipping-

---

The method of inching the body of the still below the globular part, is the same as that already described for inching a wash back. To ascertain the quantity at every inch of the globular part, proceed as follows:

METHOD OF TABULATING THE STILL.

| Dry Inches. | |
|---|---|
| Full | 1148·6209 |
| | 3·6737 |
| 1 | 1144·9472 |
| | 5·6894 |
| 2 | 1139·2578 |
| | 7·6825 |
| 3 | 1131·5753 |
| | 9·6530 |
| 4 | 1121·9223 |
| | 11·6009 |
| 5 | 1110·3214 |
| | 13·5262 |
| 6 | 1096·7952 |
| | 15·4289 |
| 7 | 1081·3663 |
| | 17·3090 |
| 8 | 1064·0573 |
| | 19·1665 |
| 9 | 1044·8908 |
| | 21·0014 |
| 10 | 1023·8894 |
| | 22·8137 |
| 11 | 1001·0757 |
| | 24·6034 |
| 12 | 976·4723 |
| | 26·3705 |
| 13 | 950·1018 |
| | 28·1150 |
| 14 | 921·9868 |
| | 29·8369 |

| | Dry Inches. | |
|---|---|---|
| | 15 | 892·1499 |
| $\frac{5}{10}$ 1st Area<br>$\frac{5}{10}$ 2d Area | | 32·2479 |
| | 16 | 859·9020 |
| | | 32·0164 |
| | 17 | 827·8856 |
| | 18 | 795·8692 |
| $\frac{5}{10}$ 1st Area<br>$\frac{5}{10}$ 2d Area | | 32·2479 |
| | 19 | 763·6213 |
| | | 32·4794 |
| | 20 | 731·1419 |
| | 21 | 698·6625 |
| | | 32·4794 |
| | 22 | 666·1831 |
| $\frac{5}{10}$ 3d Area<br>$\frac{5}{10}$ 4th Area | | 32·47075 |
| | 23 | 633·71235 |
| $\frac{5}{10}$ 4th Area<br>$\frac{5}{10}$ 5th Area | | 31·2421 |
| | 24 | 602·47025 |
| | | 30·0221 |
| | 25 | 572·44815 |
| | 26 | 542·42605 |
| | | 30·0221 |
| | 27 | 512·40395 |
| | 28 | 482·38185 |
| | | 30·0221 |
| | 29 | 452·35975 |
| | 30 | 422·33765 |
| | | 30·0221 |

| | Dry Inches. | |
|---|---|---|
| | 31 | 392·31555 |
| | 32 | 362·29345 |
| | | 30·0221 |
| | 33 | 332·27135 |
| $\frac{5}{10}$ 5th Area<br>$\frac{5}{10}$ 6th Area | | 27·06245 |
| | 34 | 305·2089 |
| | | 24·1028 |
| | 35 | 281·1061 |
| | 36 | 257·0033 |
| | | 24·1028 |
| | 37 | 232·9005 |
| | 38 | 208·7977 |
| | | 24·1028 |
| | 39 | 184·6949 |
| $\frac{9}{10}$ 6th Area<br>$\frac{1}{10}$ 7th Area | | 23·97295 |
| | 40 | 160·72195 |
| $\frac{5}{10}$ 7th Area<br>$\frac{5}{10}$ 8th Area | | 23·45365 |
| | 41 | 137.2683 |
| | | 24·1028 |
| | 42 | 113·1655 |
| $\frac{5}{10}$ 8th Area<br>$\frac{5}{10}$ 9th Area | | 24·10845 |
| | 43 | 89·05705 |
| $\frac{5}{10}$ 9th Area | | 12·05705 |
| | 43·5 | 77·0000 |
| To cover the crown | | 77· |

place, in the manner described, draw off the water into a known measure, until the surface of the water remaining in the still be one inch from the dipping-place; deduct the quantity drawn off, from the full content of the body of the still, and the remainder will be the content of the still at one dry inch. Proceed in like manner to find the content at every dry inch, until the crown only remains covered; deduct the whole quantity drawn off from the whole content of the body of the still, and the remainder will be the quantity required to cover the crown.

---

*Table of the Still as entered in the Table Book.*

| Dry Inches. | Gallons. | Area of a Tenth. | Dry Inches. | Gallons. | Area of a Tenth. | Dry Inches. | Gallons. | Area of a Tenth. | Dry Inches. | Gallons. | Area of a Tenth. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Full | 1149 | | 12 | 976 | 2·460 | 24 | 602 | $\frac{5}{10}$ 3·246<br>$\frac{5}{10}$ 3·002 | 35 | 281 | 2·410 |
| 1 | 1145 | ·367 | 13 | 950 | 2·637 | 25 | 572 | 3·002 | 36 | 257 | |
| 2 | 1139 | ·568 | 14 | 922 | 2·811 | 26 | 542 | | 37 | 233 | |
| 3 | 1131 | ·768 | 15 | 892 | 2·983 | 27 | 512 | | 38 | 209 | |
| 4 | 1122 | ·965 | 16 | 860 | $\frac{5}{10}$ 3·247<br>$\frac{5}{10}$ 3·201 | 28 | 482 | | 39 | 185 | |
| 5 | 1110 | 1·160 | 17 | 828 | 3·201 | 29 | 452 | | 40 | 161 | $\frac{9}{10}$ 2·410<br>$\frac{1}{10}$ 2·280 |
| 6 | 1097 | 1·352 | 18 | 796 | | 30 | 422 | | 41 | 137 | $\frac{5}{10}$ 2·280<br>$\frac{5}{10}$ 2·410 |
| 7 | 1081 | 1·542 | 19 | 764 | $\frac{5}{10}$ 3·201<br>$\frac{5}{10}$ 3·247 | 31 | 392 | | 42 | 113 | 2·410 |
| 8 | 1064 | 1·730 | 20 | 731 | 3·247 | 32 | 362 | | | | |
| 9 | 1045 | 1·916 | 21 | 699 | | 33 | 332 | $\frac{5}{10}$ 3·002<br>$\frac{5}{10}$ 2·410 | 43 | 89 | $\frac{5}{10}$ 2·410<br>$\frac{5}{10}$ 2·411 |
| 10 | 1024 | 2·100 | 22 | 666 | $\frac{5}{10}$ 3·247<br>$\frac{5}{10}$ 3·246 | 34 | 305 | | 43·5 | 77 | 2·411 |
| 11 | 1001 | 2·281 | 23 | 634 | | | | | | | |
| | | | | | | To Cover the Crown. | | | | 77 | |

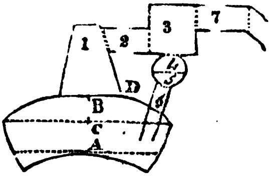
Stills in which gauges are taken, have usually a cylindrical tube fixed in the breast thereof, and elevated some inches above the top of the globular part, where the table commences; in such cases, instead of the table beginning at full, as in the preceding example, it must begin at the number of inches the top of the tube is higher than the top of the globular part. But where no such tube is fixed, the gauges must be taken from the lower part of the proper hole, or opening in the breast of the still.

TO GAUGE A STILL-HEAD.*—Take the dimensions internally, if the head is sufficiently large to admit of it; and if not, take the same externally, and allow for the thickness of the metal. Divide or reduce the different sections into figures which can be measured mathematically, and calculate the contents separately, adding the whole together for the content of the head.

---

* EXAMPLE OF A WASH STILL-HEAD.

(2.) Let the upper part of the annexed figure represent the head of the still, the body of which was the subject of the preceding example, and suppose the dimensions of the several parts to be as follows:



*1st. Section—Frustum of a Cone. (See page 129.)*

| | Inches. | Incumbrance Depth | Incumbrance Area | Net Content in Gallons. |
|---|---|---|---|---|
| Top Diameter | 13·7 | | | |
| Bottom | 30·7 | | | |
| Altitude | 39·0 | 39·0 | ·0113 | 56·7380 |

Incumbrance—A Spindle, the whole Altitude, diameter 02 0 inches, area ·0113 gallon.

*2nd Section—A Cylinder. (See page 120.)*

| | Inches | |
|---|---|---|
| Circumference | 37·0 | |
| Diameter | 11·7 | 8·5294 |
| Altitude | 22·0 | |

*3rd Section—A Cylinder. (See page 120.)*

| | Inches | |
|---|---|---|
| Circumference | 57·0 | |
| Diameter | 18·1 | 20·4138 |
| Altitude | 22·0 | |

*4th Section—Frustum of a Sphere. (See page 139.)*

| | Inches | |
|---|---|---|
| Top Diameter | 10·0 | |
| Bottom do | 18·1 | 4·8823 |
| Altitude | 07·0 | |

*5th Section—Frustum of a Sphere. (See page 139.)*

| | Inches | |
|---|---|---|
| Top Diameter | 18·1 | |
| Bottom do | 04 0 | 4·8600 |
| Altitude | 08·0 | |

*6th Section—A Cylinder. (See page 120.)*

| | Inches | |
|---|---|---|
| Circumference | 12·8 | |
| Diameter | 04·0 | 1·0872 |
| Altitude | 24·0 | |

*7th Section—A Cylinder. (See page 120.)*

| | Inches | |
|---|---|---|
| Circumference | 31·6 | |
| Diameter | 10·0 | 10·1952 |
| Altitude | 36·0 | |

Head 106·7059 + Body 1148·6209. Content of Still......1255·3268

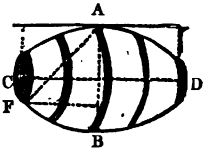
It is usual to consider the lower part of a still-head as consisting of two frustums of a sphere, and the middle part of a spheroid; but measurement by cross diameters is preferable.—*Nisbett's Gauging.*

## III. CASK GAUGING AND ULLAGING.

CASKS are close circular vessels usually bulging out in the middle, and tapering towards the ends, which are flattened. The art of finding the contents of casks is usually considered to be the most difficult part of gauging, in consequence of the various and uncertain forms which these vessels assume, and because the dimensions are necessarily taken either wholly, or in part, at the outside.

### 1. *Of the Diagonal Rod.*[*]

IF all casks were formed upon the same principles (which they ought to be,) and were not subject to change, a very ready mode of finding their contents could be devised; as their diagonals would be in certain proportions to each other; according to the proposition, that all similar solids are to each other as the cubes of their like lineal dimensions. Upon this principle was constructed the gauging-rod or stick, from the use of which, the term "gauging," probably arose; and which is still used occasionally, when no great accuracy is required. It is graduated with a line of inches and tenths, and another of gallons and tenths, called a diagonal line; and its application is easy, it being only necessary to insert the rod into the bung hole of the cask in such a manner, that the extremity of the rod may meet the head where



---

[*] OF THE DIAGONAL ROD.

This rod, which is now usually denominated the diagonal rod, or dipping rod, being 4 feet long, and divided into four equal parts by joints, was originally constructed as follows. The bung and head diameter and length of a cask, such as best agreed with the most general form of casks, were first carefully taken in inches and tenths, and its variety ascertained. Then the square of half the length was added to the square of half the sum of the bung and head diameters, and against the square root of that sum it intersects the staves of the opposite side of the cask, (as A F) and the content will be exhibited in gallons on the diagonal line, reckoning from the end of the rod to the centre of the bung-hole.

Casks are, however, not formed upon the same principles, nor upon any common principle whatever, and, they are subject to alteration by use, pressure, and other circumstances ; and, as the diagonal rod is constructed for casks of one particular kind only, its use must necessarily be very limited.*

---

measured on a straight rod or rule, were placed the true contents of the cask in gallons, found by the proper rule in the mensuration of solids. Then by the nature of similar solids, as the cube of the diagonal is to the content of the cask in gallons, so is the cube of any other number (or diagonal) proposed, to the content of any other similar cask, answering to the same diagonal.—*Moss's Gauging*.

It is found by experiment, that a cask containing 144 imperial gallons, has a diagonal of about 40 inches: therefore 144 on the rod is placed at 40 inches: and since the contents are as the cubes of the diagonals, 144: $40^3 = 64000 :: 114 : 50666\frac{2}{3}$, the cube root of which is 37; therefore 114 is put at 37, and in the same manner any other number of gallons may be placed upon the rod, corresponding with the line of inches.—*Ingram's Mathematics*, p. 234. This graduation, however, is rather higher than the diagonal rod in common use, as will be seen by the table in a subsequent page.

*To find the content of a cask by the rod.*—Put in the end covered with brass at the bung, and extend it to the opposite corner of the head, and mark the gallons and parts at the middle of the bung; then extend it to the other head of the cask, and mark the gallons and parts. Half the sum of these two (if they do not agree) will be the content of the cask.

The way in which the graduation is made, will be seen by the table just referred to, by the use of which, a common cask may be gauged with a carpenter's rule and walking stick; for the length of the diagonal being taken in inches and tenths, the table will shew the content in the column opposite to the number found.

Nearly the same result would be produced by the pen as follows. To the square of half the length of the cask, add the square of half the sum of the diameters, to get the square of the diagonal; this multiplied by its square root, and divided by $444\frac{4}{9}$ gives the content.

* Mr. Moss has given the particulars of sixty-one different forms of spheroidal casks, and forty-seven forms of other casks, the contents of which can be truly obtained by the diagonal rod, supposing it to be properly graduated. The spheroidal forms are exhibited in the following table,

### 2. *Of the different varieties of Casks.*

ALTHOUGH CASKS are of no exact geometrical form, they are measured as if they were so; and for this purpose they have been usually divided into four different *varieties*, or classes, corresponding with the solids to which they bear the nearest resemblance, viz:

| | |
|---|---|
| 1st variety. | The middle frustum of a *spheroid*. |
| 2d .. | The middle frustum of a *parabolic spindle*. |
| 3d .. | The lower frustums of two equal parabolic conoids, joined together at the greater ends. |
| 4th .. | The lower frustums of two equal cones, joined in a similar manner. |

And all casks of whatever construction, have usually been taken to constitute one of these varieties, and gauged accordingly. Thus, when a cask has been found to be much bent or arching between the middle (or bung diameter,) and the ends, (or head diameters,) it has been considered to be the middle frustum of a *spheroid*—or of the first variety. When the curvature between the middle and ends was found less arched or bent, the cask was considered to be the middle frustum of a *parabolic spindle*—

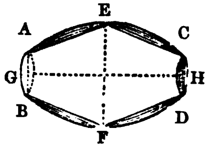
---

the first column shewing the quotient of the head divided by the bung, and the second, the quotient of the head divided by the length.

| H ÷ B. | H ÷ L. | H ÷ B. | H ÷ L. | H ÷ B. | H ÷ L. | H ÷ B. | H ÷ L. |
|---|---|---|---|---|---|---|---|
| ·60 | ·328 or ·911 | ·68 | ·386 or ·884 | ·76 | ·452 or ·838 | ·84 | 537 or ·786 |
| ·61 | ·334 or ·910 | ·69 | ·394 or ·878 | ·77 | ·461 or ·832 | ·85 | ·550 or ·780 |
| ·62 | ·341 or ·908 | ·70 | ·402 or ·872 | ·78 | ·470 or ·826 | ·86 | ·564 or ·768 |
| ·63 | ·349 or ·906 | ·71 | ·410 or ·866 | ·79 | ·480 or ·820 | ·87 | ·583 or ·750 |
| ·64 | ·356 or ·903 | 72 | ·418 or ·861 | ·80 | ·490 or ·814 | ·88 | ·607 or ·726 |
| ·65 | ·363 or ·900 | ·73 | ·427 or ·856 | ·81 | ·500 or ·807 | ·89 | ·636 or ·698 |
| ·66 | ·370 or ·895 | ·74 | 436 or ·850 | ·82 | ·512 or ·800 | ·90 | nearly ·670 |
| ·67 | ·378 or ·890 | ·75 | ·444 or ·844 | ·83 | ·525 or ·793 | | |

**Thus if the quotient of the head diameter of a spheroidal cask, divided by the bung, be ·85, and the quotient of the head, divided by the length, be either ·55 or ·78, the true content will be obtained by a properly graduated diagonal rod; and so of any of the others.**

or of the second variety. When the curve or arch between the middle and ends was very small, the cask was considered to constitute the lower frustums of two equal *paraboloids*,—or to be of the third variety; and, when there was no curvature at all between the middle and ends, the cask was considered to form the lower frustums of two equal cones,—or to be of the fourth variety. These varieties are, however, in a great measure arbitrary, there being in truth no defined species of curve between the head and bung; and most writers on this subject agree that casks are seldom, if ever, found so much curved as the frustum of a spheroid, or so straight as two frustums of a cone; and Mr. Moss considers that there is never found so sharp an angle or ridge in the middle of any cask, as there would be if it was formed of two frustums of a parabolic conoid. It is indeed evident from an inspection of the figure, that the principal dimensions of any cask (as the head and bung diameters and length, A B, C D, E F and G H) may be exactly the same as those of another, yet, by reason of the curvature of the staves, the contents of the casks may differ from each other by a very large quantity.



Dr. Hutton mentions another variety, which he considers to be the nearest approximation to casks in general. This variety is made up of a compound formation;* the middle third of the cask being taken as of the second variety, with an equal portion on each side of the simple conical form. This kind of cask may be called, for the sake of distinction, *Hutton's variety*.

---

* The idea is said to be taken from the method used by workmen in constructing casks, but there is little doubt that the division of the axis into equal thirds is purely arbitrary."—*Woollgar.*

Dr. Young operated upon twenty-one casks, whose dimensions had been carefully determined by an officer of customs, and their contents, according to Mr. Woollgar, agree best with a form lying between the second variety and Dr. Hutton's. Casks of this description may, for the purpose of the present work, be called *Young's variety.*[*]

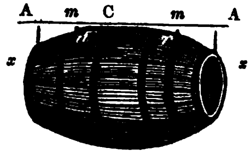
The great difficulty is in determining to which of these varieties any given cask bears the nearest resemblance. Mr. Moss has indeed given rules for distinguishing several of the varieties of casks from each other;[†] but these rules do not appear to have obtained to any great extent in practice.

If an exact *middle* diameter, at equal distances between the head and bung, could be obtained, the necessity of fixing upon a particular form or variety for the cask would be lessened, if not altogether removed; as with this diameter and the other usual dimensions, the content could be determined to the greatest nicety in almost every case, by a general rule which has been laid down in the mensuration of solids, and which is found to answer for almost

---

[*] "The number of vessels used by Dr. Young seems not sufficiently great to command confidence."—*Woollgar.* It is indeed quite futile to attempt to set up any one kind of casks, as a standard for all others.

[†] Mr. Moss's rules for finding the varieties of casks, are in substance, as follows. Let $\frac{1}{4}$ of the internal length of the cask be set off from the bulge C towards each head, on a plumb line, if the cask be standing, or on a rod, if it be lying; (i. e.) let C *m* be equal to $\frac{1}{4}$ of the internal length of the cask. Then if the perpendicular distance (*m n*) from the line or rod to the cask be equal to $\frac{1}{8}$ of the difference between the bung and head diameters, the cask is extremely near (if not exactly) the form of the middle frustum of a *parabolic spindle*, or of the second variety; but if it be less than $\frac{1}{8}$ of the difference of the head and bung diameters, the cask will be greater than the middle frustum of a parabolic spindle; and therefore may be taken as a *spheriodal* cask, or of the first variety. And if the distance (*m n*) be greater than $\frac{1}{8}$ (and less



all solids whatever their form may be; but the difficulty of obtaining such a middle diameter at the inside of a cask has prevented any extensive use being made of this general rule.*

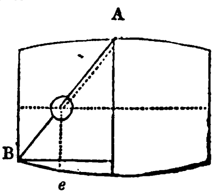
In the practice of the revenue the contents of all casks are calculated by the rule applicable to the *first variety* or the spheroidal form; and should any cask be considered to deviate from that form, a deduction in the length is made, so as to reduce it to a spheroid, as nearly as possible. This necessarily leaves much to the judgment and experience of the gauger; and the practical officers usually consider that the necessary knowledge in this respect is to be acquired only by verbal instruction and observation. The commissioners of customs have indeed furnished their officers with tables of allowances for different kinds of casks, but these tables are designed solely for the private information of their officers, at whose discretion the allowances are to be departed from or changed, so as to adapt them to the actual and ever-varying forms of the casks to be gauged.

---

than ¼) of the difference of the two diameters, the cask being then less than a parabolic spindle, may be considered to be the middle frustum of an *hyperbolic spindle.*

* Mr. Symons, Mr. Moss, and other writers, give rules for finding a middle diameter of casks, which are in substance as follows:

Get a ring to fit your gauging rod so as to slide up and down at pleasure; file a small notch in the inside of the ring for a plumb line to move up and down; measure the diagonal A B, which suppose 35·6 inches; then fix the ring and plumb line on the gauging rod at (·) equal to half the diagonal, viz: 17·8. Put the rod again into the cask, and when the plummet touches the bottom at *e*, take out the rod, holding the thread close to it so that it may retain its position. Measure the distance (·) *e*, which suppose = 16·7; this reserve. Then from half the bung diameter subtract one fourth part of the difference between the head and bung diameters. The remainder subtract from the reserved number; add double the remainder to the head diameter, and the sum will be the middle diameter required.



### 3. *Of taking the dimensions.*

IN ORDER to gauge and ullage a cask, it is necessary, in the first instance, to obtain the following dimensions as nearly as possible, in inches and tenths: 1st. the bung diameter; 2nd. the head diameter; 3rd. the length; 4th. the wet inches. For the purpose of taking these dimensions, the officers at the port, and at various other places, are furnished with four instruments, viz., a pair of long callipers, a pair of cross callipers, a bung rod, and a head rod; the use of which will be seen by the following rules.

When there are a number of casks to be gauged upon the same attendance of the officer, they are required to be

---

Another method of finding the middle diameter is to measure the distance between the cask, (at ¼ of its length at each side of the bung) and a horizontal line or rod stretched or laid across the cask; (viz., the distance between *m* and *n*, see the figure in page 222,) and to deduct such distance from the internal bung diameter; this will give the internal middle diameter nearly.

The middle diameter may also be found by boring a hole, or by taking the circumference at one fourth part of the perpendicular length of the cask; or, if the end of the vessel be out, the diameter may be obtained by actual admeasurement. (See page 192, &c.)

The general rule referred to in the text for finding the contents of a cask by means of a middle diameter, will be found in page 132, and its application to casks will be seen by the following example.

Suppose the length of a cask to be 40 inches, its bung diameter 32, its head diameter 24, and its middle diameter 30·2 inches. What is the content?

$$(32^2 + 24^2 + 60{\cdot}4^2) \times 40 \times {\cdot}0004721 = 99{\cdot}106 \text{ Gallons.}$$

Or thus, by the Table of Circular Areas.

| | | | |
|---|---|---|---|
| Middle diameter | 30·2 | Area 2·5834 × 4 = | 10·3336 |
| Bung diameter | 32 | Area.............. | 2·9005 |
| Head diameter | 24 | Area.............. | 1·6316 |

$$14{\cdot}8657 \times 40 \div 6 = 99{\cdot}104 \text{ Gall.}$$

This result proves the cask to be of a spheroidal form, of which the middle diameter may at any time be found, by adding the square of the head diameter to three times the square of the bung diameter, and ¼ of the amount will be the square of the middle diameter required. Should the middle diameter, found by admeasurement, be less than the diameter found by this rule, the cask is less than a spheroid.

placed (particularly on the quays) in regular rows, with their bung holes uppermost, and each cask exactly level and upright, and at such a distance from each other as to allow room for the play of the cross callipers, and to admit the officers to pass freely between them. It must also be ascertained whether the bung-hole be in the middle of each cask, and that the bung stave, and the stave opposite to the bung-hole, are both regular and even within, and whether the heads of the casks are equal and truly circular.

The order in which the dimensions are taken is not of much importance; but the usual practice is to find; 1st. the cross bung diameter; 2nd. the back head diameter; 3rd. the perpendicular bung diameter and wet inches; 4th. the length; and 5th. cross diameters of the front head. A mean of each dimension is obtained (when more than one is taken) and chalked on the front part of each cask, from which the particulars are afterwards transferred to the officer's book; and the content and ullage of the casks are calculated from such dimensions.*

TO FIND THE HEAD DIAMETER.—Place the lower edge of the crooked brass which is on the end of the *head rod*,† within the chimb of the cask close to the head; then move the slide until the brass index intersects the middle of the opposite chimb, about $\frac{2}{3}$ up the chimb. This will give the internal head diameter of the cask, on the lower line of the stock, directly opposite to the index on the slide.

---

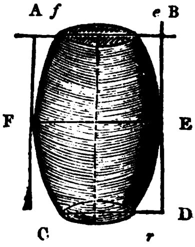
* Each cask should be turned at least half over and examined; and each tier cross and back headed before the dimensions are taken.

† In default of a head rod, measure with a rod or tape the distance between the inside of the chimb close to the head, and the outermost sloped edge of the opposite stave, and this will generally be the head diameter very nearly; although something will of course depend on the thickness of the staves which must be provided for accordingly.

TO FIND THE BUNG DIAMETER. — Lay the *cross callipers*[*] over the bung hole of the cask with their legs downwards, and contract them until they touch the bulge of the cask on each side, when the external bung diameter will be shewn on the stock of the callipers. Take two other horizontal diameters in other parts of the centre, and chalk the mean or average, as the cross, on the side of the bung, after deducting the thickness of the staves. With the bung rod examine the bottom and sides to ascertain if there are any irregularities in the staves or form. If the cask appears fairly made, take the mean of the horizontal and perpendicular diameters for the bung dimension. Should two or three of the staves at the top or bottom of the cask appear flattened, and the rest of the cask circular, add to the perpendicular found as many tenths of an inch as the staves are considered to be depressed; and then take the mean for the bung diameter. If, on the contrary, two or three of the staves at the bung appear forced up, so as to make what is termed a *cocked bung*,—or if the rod has little play at the bottom of the cask, deduct from the perpendicular found, as many tenths of an inch as the case

---

[*] If there be no cross callipers, the bung diameter of a standing cask may be found by laying a rod across the head, and another, or a plumb line across the bung, perpendicularly with the rod across the head, as A B C D; then twice the distance A *f* or B *e* added to the distance *f e*, will be the external bung diameter, from which the thickness of the staves must be deducted for the internal bung diameter. If the cask be lying, the same means may be adopted, in addition to which, the internal bung diameter may be measured by introducing a rod into the cask at the bung hole, and measuring the diameter as directed in the text. Another method of finding the external diameter of a cask, is to measure the circumference, and divide the same by 3·1416.



seems to require, before taking the mean for the bung diameter. This bung diameter is taken, both in the cross and dip, as if the staves of the cask were one inch thick, and this thickness must be deducted from the actual dimensions; but, in order to ascertain whether this is the actual thickness of a cask of irregular formation, (such as rum puncheons, brandy puncheons, madeira pipes, and other large sized casks,) it is necessary to bore occasionally in the centre of the stave, at about one third distance from the head to the bung, and also the head, in the piece next the centre; ascertaining the thickness with the wood-gauge or graduated brass prepared for the purpose: and, should the staves be found to be more or less than an inch thick, the mean difference of the actual thickness must be added to, or deducted from the dimensions found, as before directed.

---

### EXAMPLES.

(1.) The staves of a rum puncheon on boring average eight-tenths of an inch. There is then too little upon the cross by two-tenths each stave,

| | |
|---|---|
| viz: | 4 tenths. |
| Upon the perpendicular | 2 |
| | 2) 6 |
| Mean to be added | 3 |
| Bung found | 32·1 |
| Bung diameter to be taken | 32·4 |

(2.) The staves of a Madeira pipe average twelve-tenths thick. There

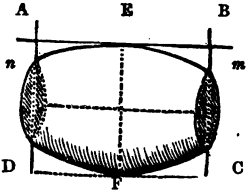
| | |
|---|---|
| is then too much upon the cross | 4 tenths. |
| Upon the perpendicular | 2 |
| | 2) 6 |
| Mean to be deducted | 3 |
| Bung found | 28·7 |
| Bung diameter to be charged | 28·4 |

Great care and precision are requisite in taking the bung diameter, it being double the value of the head; and hence fraud is not unfrequently attempted to prevent the true dimensions being taken, which it is necessary for the officers to guard against.

TO TAKE THE LENGTH.—Lay the *long callipers** over the bung hole of the cask perfectly level, with their legs downwards, and contract them until their ends come in contact with the heads of the cask; first allowing the outer limb to touch the back head, and then bringing the inner one gently up to the front head, taking care not to press the rule. The length of the cask will then be shewn on the stock, as the long callipers throw off two inches for the supposed thickness of the two heads. Take two other lengths, one on each side of the bung, so that the three lengths thus taken, may be at equal distances from each other; divide the sum of these lengths by 3, for the mean length of the cask. If the content of the cask is to be calculated according to the rule for the first variety, or middle frustum of a spheroid, which is the practice, as well in the excise as in the customs, a proper allowance† or deduction must be made on the length, so as to reduce the cask to the first variety. Casks imported from different countries vary much in their form and construction, and it is therefore necessary to vary these allowances and deductions accord-

---

* If the officer be not provided with long callipers, he may apply a straight rod A B, to the bulge of the cask, and at right angles to it, two other rods, A D and B C, touching the chimbs at each end, and making A *n* equal to B *m*: then measure the distance from A to B, where the three rods intersect each other; from this, subtract the depth of the chimb, and the thickness of both heads, as nearly as can be ascertained. The difference will be the internal length of the cask.



† A table of the allowances which it is usually necessary to make on the different kinds of casks, so as to reduce them to a spheroidal form will be found in a subsequent page; but, for the reason given in the text, and in page 223, this table can only be used to assist the officer's judgment, and must not be considered as official or permanent.

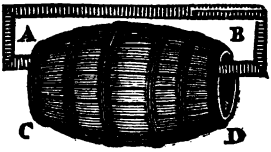
ingly. An allowance in or addition to the thickness of the head, as shewn on the rule, must also be made, should it be found to exceed or be less than two inches.*

TO FIND THE WET INCHES.—Bring the lower end of the brass on the *bung rod* to the actual bung charged, if it be lowered; and, after wiping the rule, re-dip it into the cask, taking care to hold the brass firm against the rule that it may not be forced up, and the true wet will be shewn upon the rod. If the bung be raised, there must be added to the wet inches shewn, as many tenths as it is raised.†

---

* EXAMPLE.

Let the annexed figure represent a port pipe with the long callipers in the act of taking the length of the cask over the bung hole, and suppose three lengths to be taken as follows, viz., 49·2, 48·8, 48·7 and their sum ÷ 3= 48·9 mean.



| | |
|---|---|
| Suppose it be considered necessary to add for the heads 2·0—1·6 = | 0·4 |
| | 49·3 |
| And to deduct for the variety.................................. | 0·6 |
| The true length as charged would be........................ | 48·7 |

In practice, these calculations are made mentally, which shortens the operation.—*Nisbett's Gauging*.

† The wet inches are to be taken as they are actually found in the cask without regard to the cask having a flat top, or cocked up bung, because, the compressing the cask into the true form, supposed to be done by the allowance for the bung diameter, would neither raise nor depress the liquor in the body of the cask. If the bottom be flattened, there must be added to the wet inches shewn upon the rod, the same number of tenths which have been added to the bung, as the forcing the two staves into a circular form would not depress the liquor, although it would allow the bung rod to pass lower down, and consequently shew a greater bung and wet. Spirits being subject to expand, more or less, according to the different degrees of heat, an allowance is to be made upon the wet inches in hot weather from 4 to 5 tenths, and in moderate weather from 2 to 4 tenths, but nothing in cold weather. Upon wines an allowance is generally made for the swell of the rule, in hot weather, 2 tenths, and at other times, 1 tenth.

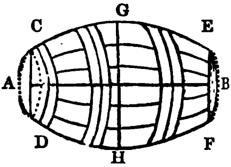
### 4. *Of finding the content.*

THERE are various modes of finding the content of a cask; the most common of which is by the head rod, or sliding rule; but rules are subjoined for casting by the pen, should that mode of working be preferred or considered necessary to check the instrumental calculation.

TO CAST THE CONTENT WITH THE HEAD ROD.—Set the brass, on the sliding piece, to the head diameter on the lower line of the rule; then look for the bung diameter on the same line, and observe what number it cuts on the middle line of the slide; find the same number on the lower line of the slide, and immediately under it, on the lower line of the rule, is the mean diameter. Set the brass on the upper end of the slide, to the length of the cask on the upper line of the rule; look for the mean diameter on the upper line of the slide, and over it, on the upper line of the rule, is the content in gallons.*

EXAMPLE BY THE HEAD ROD.

(1.) Let the length A B of a cask be 50, head diameter C D = E F 22·7, bung diameter G H 31·3 inches; required its content.



Set the brass cock to 22·7, and immediately over 31·3, on the middle or spheroid line of the slide, is 6. Find 6 on the lower line of the slide which cuts 28·7 (the mean diameter) on the lower line of the rule; or (which is the same thing) add 6 to the head diameter. Set the brass end of the slide (which is the gauge point for gallons,) to 50·0 the length; find 28·7 (the mean diameter) on the upper line of the slide, immediately over which is 116, the content in gallons.

Should any one of the dimensions be thrown off the rule, use half the dimension thrown off, and double the answer.

The contents of the casks in the table, *infra*, (page 246) having been calculated by the head rod, may be considered as examples under this rule, and selections made therefrom for practice.

---

* This is the old and official rule; but it must be recollected that it only gives the content when the cask is of the first variety; and therefore before the content is cast, the cask must either be ascertained to be of a spheroidal form, or reduced to that form by an allowance on the length. See page 228.

To FIND THE CONTENT WITH THE LINE X ON THE HEAD ROD OR SLIDING RULE.—Set the head diameter on A, to the bung diameter on B; then opposite unity (or the index to X, on B,) is a gauge point on the stock or at the end of A (applicable to the particular variety of the cask,) which must be reserved. Set the reserved gauge point on D to the length on C, then opposite the bung diameter on D is the content in gallons on C.*

---

* EXAMPLES BY THE LINE X.

(2) Suppose the dimensions of a cask are: length 40 inches, bung diameter 32, and head diameter 24 inches; what is its content according to the first, second, and Hutton's varieties, respectively?

| On A | | On B | | On B | | On X | |
|---|---|---|---|---|---|---|---|
| As 24 | : | 32 | : : | Index | : | 20·33 | Gauge point for a Spheroid. |
| Head | | Bung | | or Unity. | | 20·43 | " 2nd variety. |
| | | | | | | 20·93 | " Hutton's var. |

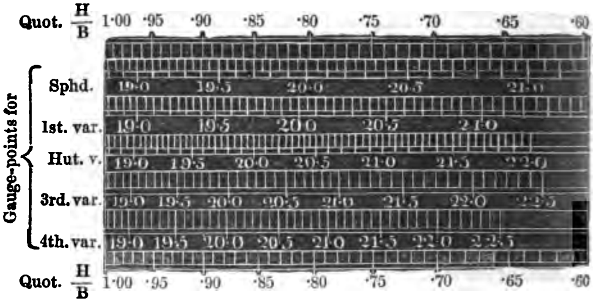
| | On D | | On C | | On D | | Content on C |
|---|---|---|---|---|---|---|---|
| As the Gauge point | 20·33 | : | 40· | : : | 32· | : | 99 Gallons, 1st variety. |
| | 20·43 | | Length | | Bung | | 98 Gallons, 2nd variety. |
| | 20·93 | | | | | | 93·5 Gallons, Hutton's variety. |

This is the easiest mode of computing the contents of casks which has yet been discovered, except Dr. Young's method which does not appear to have been completed; and it is also the most correct mode, where only three dimensions are taken, and where instrumental computation is adopted. It likewise possesses the advantage of adapting itself to any variety, as will be best explained in the words of its inventor, Mr. Woollgar. (See page 179.) "Notwithstanding the various expressions of the rules for finding the content of a cask, I find that they may all be brought into one general form, viz: $C = \frac{1}{3r} L B^2 (x + y q^2 + z q)$ wherein $r = 353·036$, the cylindrical inches in a gallon, $q = \frac{H}{B}$ and $y$ and $z$ co-efficients, the sum of which, together with $x$, is always equal to 3; and in the values given to these three quantities, the real difference between the rules consists.

| | | $x$ | $y$ | $z$ |
|---|---|---|---|---|
| 1 | Spheroidal form .................... | 2 | 1 | 0 |
| 2 | Parabolic Spindular ................ | 1·6 | 0·6 | 0·8 |
| | [Young's variety, (see p. 222)..... | 1·4 | 0·6 | 1·0] |
| | Hutton's variety ................. | 1·3 | 0·83 | 0·87 |
| 3 | Parabolic Conoidal................. | 1·5 | 1·5 | 0 |
| 4 | Conical .......................... | 1· | 1· | 1· |

"We may adopt any values we please for $x$, $y$, $z$ (their sum remaining constant) that will give a content according best with the actual average of casks, and any person may easily obtain a rule of calculation corresponding with the average of 50 or 100 casks, which he may select as the foundation of the process, thus: Find the value of $q$, and also of $\frac{3rC}{LB^2}$

TO FIND THE CONTENT ON THE SLIDING RULE.—I. If the line X is not marked on the sliding rule, the proper gauge-point may be found as follows: divide the head by the bung diameter, (which can be readily performed on the rule,) and under or over the quotient in the annexed diagram, will be found a gauge point applicable to the particular variety of the cask, and which can be worked on the lines C and D, as directed in the foregoing rule.*



---

for each cask separately; then pursue the graphic method for the delineation of a regular curve, using the latter values as ordinates, and the former as abscisses; the ordinates of the adjusted curves are afterwards to be analyzed into the three terms which constitute the factor $(x + y q^2 + z q)$. These being obtained, the formula for graduating the line X upon a sliding rule is $\log \left\{ \sqrt{\left(\frac{3r}{yg^2} - \frac{4yx - z^2}{4y^2}\right)} - \frac{z}{2y} \right\}$, $g$ being the gauge point whose position is to be laid down. See the notes and examples in p. 179.

* EXAMPLES APPLICABLE TO RULE I.

(3) Let the dimensions of a cask be the same as in the last example (p.231) viz: H. 24, B. 32, L. 40. Required the content according to the different varieties.

24 ÷ 32 = ·75. Look for ·75 in the top line of the diagram, (reading from left to right;) and immediately under it (reading from right to left,) will be found the following gauge points applicable to the particular varieties, and to be used as before, viz:

| | On D | On C | On D | On C |
|---|---|---|---|---|
| As the Gauge Point | 20·33<br>20·43<br>20·93<br>21·26<br>21·4 | 40 : : | 32 : | 99 Gallons, 1st variety.<br>98 Gallons, 2nd variety.<br>93·5 Gallons, Hutton's variety.<br>90·6 Gallons, 3rd variety.<br>89·5 Gallons, 4th variety. |

RULE II.—Find the difference between the head and bung diameter on the edge of the rule, and against it on some rules (on lines called *variety* lines) is a number to be added to the head to get the mean diameter, which must be used as if the vessel were a cylinder, thus: Set the circular gauge point for gallons (18·79) on D, to the length on C; then opposite the mean diameter on D, is the content in gallons on C.*

---

The gauge-points applicable to Dr. Hutton's variety of cask have been published in several works on gauging; and in Nisbett's gauging, they are represented as remarkably easy and expeditious; but they do not appear to have been acted upon by the officers of the revenue, partly because all casks have been measured by the rule for the 1st variety, and partly because they were not expressed on the rule itself, as they are at present by the line X; see pages 179, 231. The idea of these gauge points is said to have been suggested by Mr. John Lowry, of the Military College, Sandhurst, (formerly an officer of Excise,) who, at the same time, gave a table of factors for multiplying by the square of the bung diameter, and by the length, to find the content. The formula may be expressed as follows: $C = B^2 L x$, where $x$ is found from $\frac{H}{B}$ thus: $x = ·00031473 \times \left\{ 39 + 25 \left(\frac{H}{B}\right)^2 + 26 \left(\frac{H}{B}\right) \right\}$. The fraction $\frac{H}{B}$ taken in succession at ·50 ·51 ·52 &c. up to unity, is arranged in a table, and the quantity $x$ (corresponding to such values, and constituting the factors referred to) set opposite. The gauge points are the square roots of the reciprocal of the multiplier, and may be thus found by logarithms — ½ log $x$ = log. gauge point. The gauge points for the other varieties are found by a similar process.

* EXAMPLE APPLICABLE TO RULE II.

(4.) The length of a cask is 45, the bung diameter 36, and the head diameter 27 inches; what is its content for the 1st. and 2nd. varieties, respectively?

36 — 27 = 9· Against 9 on the line of inches is 6·33 on the line marked spheroid; and this sum added to 27, gives 33·33: then

On D On C On D On C
As 18·79 : 45 : : 33·3 141·3 Gallons.

Against 9 on the line of inches is 5·75, on the line marked 2nd. variety, and this added to 27 gives 32·75; then

As 18·79 : 45 : : 32·75 : 136 Gallons.

This rule, so far as relates to casks of the first variety, is nearly the same as that given for the head rod.

To FIND THE CONTENT BY THE PEN.—I. Multiply the difference between the head and bung diameters,

| When it is 6 inches or less, by | and when it exceeds 6 inches by | for the | variety. |
|---|---|---|---|
| ·68 | ·7 | 1st | |
| ·62 | ·64 | 2d | |
| ·55 | ·57 | 3rd | |
| ·5 | ·52 | 4th | |

and add the product to the head diameter; which sum will be a mean diameter between those of the head and bung. Then find the content of a cask as a cylinder, either by the proper rule in the mensuration of solids, or by reference to the table of circular areas.*

RULE II.—Having ascertained to what variety the cask belongs, find the content of a solid corresponding with such variety, according to the proper rule in the mensuration of solids; which content, if a proper allowance be made for the thickness of the wood, will be the answer required. If the variety be Dr. Hutton's, (see page 221)

---

* This easy and general rule has usually been adopted in the excise, and agreeably thereto, the several varieties are graduated on the sliding rule; but a little consideration will serve to shew that it is only an approximation to the truth, and must not be relied on where great nicety is required.

EXAMPLES APPLICABLE TO RULE I.

(5) Required the content of a cask of each of the following varieties, of which the length is 40, the bung diameter 32, and the head diameter 24 inches.

| 1st. Variety. | 2nd. Variety. | 3rd. Variety. | 4th. Variety. |
|---|---|---|---|
| 32 — 24 = 8 × ·7 = 5·6 + 24 = 29·6 × 29·6 × 40 ÷ 353·036 = 99·27$\dot{1}$ Gall. content. | 32—24 = 8 × ·64 = = 5·12 + 24 = 29·12 × 29·12 × 40 ÷ 353·036 = 96·07$\dot{8}$ Gall. content. | 32—24 = 8 × ·57 = 4·56 + 24 = 28·56 × 28·56 × 40 ÷ 353·036 = 92·41$\dot{8}$ Gall. content. | 32—24 = 8 × ·52 = 4·16 + 24 = 28·16 × 28·16 × 40 ÷ 353·036 = 89·84$\dot{7}$ Gall. content. |

Or, by the mean diameter, and table of circular areas, thus;

| 29·6 = 2·4818 × 40 = 99·272 Gall. | 29·12 = 2·4019 × 40 = 96·076 Gall. | 28·56 = 2·3104 × 40 = 92·416 Gall. | 28·16 = 2·2462 × 40 = 89·848 Gall. |
|---|---|---|---|

(6.) Let the length be 45 inches, the bung diameter 36, and the head diameter 30 inches. Required the content according to each of the above varieties?

Answer: 1st. variety, 148·05.—2nd. variety, 144·9.—3rd. variety, 141·34. —4th variety. 138·8 gallons.

See answers to the same questions on the opposite page.

add into one sum 39 times the square of the bung diameter, 25 times the square of the head diameter, and 26 times the product of the two diameters, then multiply the sum by the length, and the product by ·000031473 for the content in gallons.*

**Rule** III.—Find the head diameter and bung diameter respectively, in the " Tables of factors for head and bung diameters,"† take out of such tables the factors opposite to such diameters respectively, and add the same together; and the sum being multiplied by the length of the cask, will

---

* EXAMPLES APPLICABLE TO RULE II.

(7.) Required the content of a cask of each of the following varieties, of which the length is 40, the bung diameter 32, and the head diameter 24 inches.

| 1st. Variety, see rule in p. 142. | 2d. Variety. See rule in p. 146. | Hutton's Variety. See the above rule. | 3rd. Variety. See rule in p. 143. | 4th. Variety. See rule in p. 130. |
|---|---|---|---|---|
| $(2 \times 32^2 + 24^2) \times 40 = 104960$<br>$·0009442$<br>Gallons, content 99·1032 | $(2 \times 32^2 + 24^2 - ·4 \times 8^2) \times 40 = 103936$<br>$·0009442$<br>Gallons, content 98·1364 | $(32^2 \times 39 + 24^2 \times 25 + 32 \times 24 \times 26) \times 40 \times ·000031473$<br>= 93·542 Gallons, content. | $(32^2 + 24^2) \times 20 \times ·0028326 = 90·6432$<br>Gallons, content. | $(56^2 - 32 \times 24) \times 40 \times ·0009442 =$<br>89·4346 Gallons, content. |

(8.) Let the length be 45 inches, the bung diameter 36, and the head diameter 30 inches. Required the content according to each of the above varieties?

Answer: 1st. variety, 148·3716.—2nd. variety, 147·7597.—Hutton's variety, 142·—3rd. variety, 139·9588.—4th. variety, 139·194 gallons.

If a middle diameter, between the bung and head, has been obtained (which is the most correct method of cask gauging) the contents may be cast by the rule in page 224.

† Tables of this description, applicable to the spheroidal form of casks, being two-thirds and one-third of the respective areas of the bung and head diameter, have been inserted in several works on gauging. See Gutteridge's Gauger, p. 444; Symon's, (Maynard's edition,) p. 202, &c. The " Tables of differences" is the invention of Mr. Woollgar, founded upon the

give the content as the frustum of a spheroid. Should the cask be of the 2nd variety, find a factor in the "Table of differences between the head and bung diameters," opposite to the number answering to the difference between the head and bung diameter, and subtract this last factor from the sum of the two first found, and then multiply by the length as before; the product will be the content as the frustum of a parabolic spindle.*

## 5. *Of ullaging.*

WHEN a cask is only partly filled it is said to be on *ullage*, the vacuity or space being called the dry inches, and the depth of liquor or materials the wet inches. The usual mode of casting such ullage, is by the head rod or sliding rule, although in most cases, these instruments give only an approximation to the truth; by the pen, the rules are too tedious for ordinary practice, but one or two of them

---

same principles as the line X on the sliding rule, and may be formed for any variety or description of casks, as follows: the values of the characters being the same as in p. 231, note.

| Argument. | Tabulated values. |
|---|---|
| Table 1, Bung Diameter ............ | $\frac{x + \frac{1}{2} z}{3 r} B^2$ |
| Table 2, Head Diameter............ | $\frac{y + \frac{1}{2} z}{3 r} H^2.$ |
| Table 3, Difference of the Diameters | $\frac{\frac{1}{2} z}{3 r} (B - H)^2$ |

* EXAMPLE APPLICABLE TO RULE III.

(9) Let the dimensions of a cask be as before, viz : H. 24, B. 32, L. 40; required its content as of the 1st. and 2nd. varieties, respectively.

| 1st. Variety. | | 2nd. Variety. | |
|---|---|---|---|
| 24 H Tabular number .... | ·5439 | 24 H Tabular number.... | 0·5439 |
| 32 B Tabular number ..... | 1·9337 | 32 B Tabular number.... | 1·9337 |
| | 2·4776 | | 2·4776 |
| | 40 | 8 Diff. Tabular number | 0·02417 |
| Gallons, answer.... | 99·1040 | | 2·45343 |
| | | | 40 |
| *See the Tables in p.* 244, 245. | | Gallons, answer.... | 98·13720 |

are inserted, in order that the correctness of the instrumental calculations may be tested, if necessary.

A standing cask requires a different calculation from a lying cask, and in using the sliding rule, we are more subject to error in the latter, than in the former; but, as the ullage in lying casks, especially on importation, is usually very small, the error is seldom of importance.

TO CAST THE ULLAGE OF A LYING CASK BY THE HEAD ROD, OR SLIDING RULE, OR ULLAGE RULE.—Place the bung diameter on the lower line of the slide (B or C) to 100 on the lower line of the rule, (Seg Ly); find the wet inches to the left of the bung on the same line, (B or C) under which, on the lower line of the rule (Seg. Ly) is a segment to be reserved; find the segment on the slide (B or C) which place to 100 on A; look for the full content of the cask on A, and directly under, on the slide (B or C) will be the ullage content, or quantity of liquor in the cask.[*]

TO FIND THE ULLAGE OF A STANDING CASK BY THE HEAD ROD, OR SLIDING RULE, OR ULLAGE RULE.—Proceed

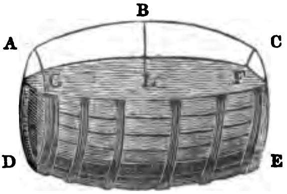
---

[*] EXAMPLE OF A LYING CASK.

(1.) Find the wet ullage of a lying cask of the following dimensions.

| Bung | Wet | Content |
|---|---|---|
| 31·3 | 26·5 | 116 |

on B or C on seg. L on B or C on seg. L
As 31·3 : 100 : 26·5 : 91·8
On B On A On A On B
Then as 91·8 : 100 :: 116 : 106·7 ullg.
On B On A On B On A
Or as 100 : 91·8 : : 116 : 106.7.



Or, instead of the latter operation, multiply the content by the segment, and the product, after pointing off two decimals more than in common multiplication, will be the required ullage.

The dry ullage will be obtained in the same manner, the dry inches being used instead of the wet. Therefore should the number of wet inches fall off the rule, find the dry ullage, and subtract it from the content for the wet inches. See the note and example in p. 181.

in the same manner as for a lying cask, using the line marked Seg. St instead of that marked Seg. Ly.*

**To ullage a lying cask by the pen.**—Divide the wet inches by the bung diameter to three places of decimals; and if the quotient exceeds ·500, add to such quotient one fourth of the excess; but if it be less than ·500, subtract one fourth of the deficiency; then multiply the whole content of the cask by the sum in the first case, or by the remainder in the second; and the product will be the ullage required.†

---

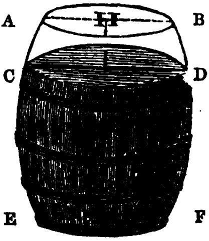
* EXAMPLE OF A STANDING CASK.

(2) Find the wet ullage of a standing cask of the following dimensions.

| Wet | Length | Content |
|---|---|---|
| 31·2 | 40 | 98 gallons. |

On B or C On Seg. St. or B C On Seg. St.
As 40 : 100 : : 31·2 : 80·4
On B On A On A On B
Then as 80·4 : 100 : : 98 : 78·7 galls. ullage
On B On A On B On A
Or as 100 : 80·4 : : 98 : 78·7 gallons ullg.

Or the latter operation may be performed by multiplication, as for a lying cask, see p. 237. See also the note and example in p. 181.



† EXAMPLE OF A LYING CASK.

(3.) Let the dimensions of a lying cask be as before: B. 31·3, W. 26·5, C. 116 G. Required the ullage.

26·5 ÷ 31·3 = ·846, which exceeds ·500 by ·346, one-fourth part of which is ·0865. Then ·846 + ·0865 = ·9325 the multiplier, hence 116 × ·9325 = 108·17 gallons, ullage.

This rule is the one in general use by the excise officers, although it is somewhat less correct in many cases, than the ullage lines on the sliding-rule. The following rule is sometimes substituted.

From five times the product of the content and wet inches, subtract the product of the content multiplied by half the bung, the remainder divided by four times the bung, gives the liquor in the cask. The dry inches will give the vacuity.

*To find the wet or dry inches when any certain quantity has been drawn out of the cask.*—Add the product of the content multiplied by half the bung, to four times the product of the quantity drawn, and bung diameter; divide the sum by five times the content, this gives the dry inches; the quantity in the cask will give the wet inches.—*Roose's Wine Dealer's Guide.*

TO ULLAGE A STANDING CASK BY THE PEN.—Divide the wet inches by the length of the cask to three places of decimals; and if the quotient exceeds ·500, add to such quotient one tenth of the excess; but if it be less than ·500 subtract one tenth of the deficiency; then the whole content of the cask being multiplied by the sum in the first case, or by the remainder in the second, will give the ullage required.*

### 6. *Of inching casks.*

TO INCH AND TENTH A CASK TO CORRESPOND WITH THE ULLAGE RULE.—First find the ullage of the cask at two or three inches from the bottom, and divide the content of the ullage by the depth, reduced into tenths, to two or three places of decimals. This will give a common addend for that depth; and, by proceeding to ullage the cask at any number of even inches, a common addend will be obtained for each portion of the cask, from which a table book may be formed.†

---

* EXAMPLE OF A STANDING CASK.

(4.) Find the wet ullage of a standing cask of the following dimensions. Wet 31·2, Length 40, Content 98.

31·2 ÷ 40 = ·780, which being more than ·500 by ·280 add one tenth of the excess, viz:—·028 to ·780 = ·808 × 98 = 79·184 gallons ullage.

Another mode of finding the ullage of a standing cask is, as follows: From 11 times the product of the content and wet inches, subtract the product of the content multiplied by half the length; the remainder divided by ten times the length, gives the liquor in the cask.

*To find the wet or dry inches in a standing cask when any certain quantity has been drawn out.*—To ten times the product of the quantity drawn, and the length of the cask, add the product of the content multiplied by half the length; that sum divided by eleven times the content, gives the dry inches. The quantity in the cask gives the wet inches.—*Rouse's Guide.*

† A more certain mode of inching a cask is by pouring in water from a known measure, and taking the dip from time to time, either in putting in or drawing out the water. From the contents found on the respective dips, a table may be formed. If the cask be well made it may be sufficient to fill it to half its depth and calculate the corresponding sections of the other half according to the dips found in the lower half.—*Nisbett's Gauging.*

## 7 *Gauging Tables.*

### No. 1.

**TABLE** *for* **CALCULATING** *the* **NET BUSHELS OF MALT** *required to be entered on the specimen immediately over the first gauge in the Couch.*—See Board's Order. 1st. Nov. 1836.

By Mr. J. WILD, Supervisor. Ipswich.

| Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·815 | 41 | 33·41 | 81 | 66·01 | 121 | 98·61 | 161 | 131·21 | 201 | 163·81 | 241 | 196·4 |
| 2 | 1·63 | 2 | 34·23 | 2 | 66·83 | 2 | 99·43 | 2 | 132·03 | 2 | 164·63 | 2 | 197·2 |
| 3 | 2·44 | 3 | 35·04 | 3 | 67·64 | 3 | 100·24 | 3 | 132·84 | 3 | 165·44 | 3 | 198·0 |
| 4 | 3·26 | 4 | 35·86 | 4 | 68·46 | 4 | 101·06 | 4 | 133·66 | 4 | 166·26 | 4 | 198·8 |
| 5 | 4·07 | 5 | 36·67 | 5 | 69·27 | 5 | 101·87 | 5 | 134·47 | 5 | 167·07 | 5 | 199·6 |
| 6 | 4·89 | 6 | 37·49 | 6 | 70·09 | 6 | 102·69 | 6 | 135·29 | 6 | 167·89 | 6 | 200·4 |
| 7 | 5·70 | 7 | 38·30 | 7 | 70·90 | 7 | 103·50 | 7 | 136·10 | 7 | 168·70 | 7 | 201·3 |
| 8 | 6·52 | 8 | 39·12 | 8 | 71·72 | 8 | 104·32 | 8 | 136·92 | 8 | 169·52 | 8 | 202·1 |
| 9 | 7·33 | 9 | 39·93 | 9 | 72·53 | 9 | 105·13 | 9 | 137·73 | 9 | 170·33 | 9 | 202·9 |
| 10 | 8·15 | 50 | 40·75 | 90 | 73·35 | 130 | 105·95 | 170 | 138·55 | 210 | 171·15 | 250 | 203·7 |
| 11 | 8·96 | 1 | 41·56 | 1 | 74·16 | 1 | 106·76 | 1 | 139·36 | 1 | 171·96 | 1 | 204·5 |
| 12 | 9·78 | 2 | 42·38 | 2 | 74·98 | 2 | 107·58 | 2 | 140·18 | 2 | 172·78 | 2 | 205·3 |
| 13 | 10·59 | 3 | 43·19 | 3 | 75·79 | 3 | 108·39 | 3 | 140·99 | 3 | 173·59 | 3 | 206·1 |
| 14 | 11·41 | 4 | 44·01 | 4 | 76·61 | 4 | 109·21 | 4 | 141·81 | 4 | 174·41 | 4 | 207·0 |
| 15 | 12·22 | 5 | 44·82 | 5 | 77·42 | 5 | 110·02 | 5 | 142·62 | 5 | 175·22 | 5 | 207·8 |
| 16 | 13·04 | 6 | 45·64 | 6 | 78·24 | 6 | 110·84 | 6 | 143·44 | 6 | 176·04 | 6 | 208·6 |
| 17 | 13·85 | 7 | 46·45 | 7 | 79·05 | 7 | 111·65 | 7 | 144·25 | 7 | 176·85 | 7 | 209·4 |
| 18 | 14·67 | 8 | 47·27 | 8 | 79·87 | 8 | 112·47 | 8 | 145·07 | 8 | 177·67 | 8 | 210·2 |
| 19 | 15·48 | 9 | 48·08 | 9 | 80·68 | 9 | 113·28 | 9 | 145·88 | 9 | 178·48 | 9 | 211·0 |
| 20 | 16·30 | 60 | 48·90 | 100 | 81·50 | 140 | 114·10 | 180 | 146·70 | 220 | 179·30 | 260 | 211·9 |
| 1 | 17·11 | 1 | 49·71 | 1 | 82·31 | 1 | 114·91 | 1 | 147·51 | 1 | 180·11 | 1 | 212·7 |
| 2 | 17·93 | 2 | 50·53 | 2 | 83·13 | 2 | 115·73 | 2 | 148·33 | 2 | 180·93 | 2 | 213·5 |
| 3 | 18·74 | 3 | 51·34 | 3 | 83·94 | 3 | 116·54 | 3 | 149·14 | 3 | 181·74 | 3 | 214·3 |
| 4 | 19·56 | 4 | 52·16 | 4 | 84·76 | 4 | 117·36 | 4 | 149·96 | 4 | 182·56 | 4 | 215·1 |
| 5 | 20·37 | 5 | 52·97 | 5 | 85·57 | 5 | 118·17 | 5 | 150·77 | 5 | 183·37 | 5 | 215·9 |
| 6 | 21·19 | 6 | 53·79 | 6 | 86·39 | 6 | 118·99 | 6 | 151·59 | 6 | 184·19 | 6 | 216·7 |
| 7 | 22·00 | 7 | 54·60 | 7 | 87·20 | 7 | 119·80 | 7 | 152·40 | 7 | 185·00 | 7 | 217·6 |
| 8 | 22·82 | 8 | 55·42 | 8 | 88·02 | 8 | 120·62 | 8 | 153·22 | 8 | 185·82 | 8 | 218·4 |
| 9 | 23·63 | 9 | 56·23 | 9 | 88·83 | 9 | 121·43 | 9 | 154·03 | 9 | 186·63 | 9 | 219·2 |
| 30 | 24·45 | 70 | 57·05 | 110 | 89·65 | 150 | 122·25 | 190 | 154·85 | 230 | 187·45 | 270 | 220·0 |
| 1 | 25·26 | 1 | 57·86 | 1 | 90·46 | 1 | 123·06 | 1 | 155·66 | 1 | 188·26 | 1 | 220·8 |
| 2 | 26·08 | 2 | 58·68 | 2 | 91·28 | 2 | 123·88 | 2 | 156·48 | 2 | 189·08 | 2 | 221·6 |
| 3 | 26·89 | 3 | 59·49 | 3 | 92·09 | 3 | 124·69 | 3 | 157·29 | 3 | 189·89 | 3 | 222·4 |
| 4 | 27·71 | 4 | 60·31 | 4 | 92·91 | 4 | 125·51 | 4 | 158·11 | 4 | 190·71 | 4 | 223·3 |
| 5 | 28·52 | 5 | 61·12 | 5 | 93·72 | 5 | 126·32 | 5 | 158·92 | 5 | 191·52 | 5 | 224·1 |
| 6 | 29·34 | 6 | 61·94 | 6 | 94·54 | 6 | 127·14 | 6 | 159·74 | 6 | 192·34 | 6 | 224·9 |
| 7 | 30·15 | 7 | 62·75 | 7 | 95·35 | 7 | 127·95 | 7 | 160·55 | 7 | 193·15 | 7 | 225·7 |
| 8 | 30·97 | 8 | 63·57 | 8 | 96·17 | 8 | 128·77 | 8 | 161·37 | 8 | 193·97 | 8 | 226·5 |
| 9 | 31·78 | 9 | 64·38 | 9 | 96·98 | 9 | 129·58 | 9 | 162·18 | 9 | 194·78 | 9 | 227·3 |
| 40 | 32·60 | 80 | 65·20 | 120 | 97·80 | 160 | 130·40 | 200 | 163·00 | 240 | 195·60 | 280 | 228·2 |

| Tenths | Frac. | Tenths | Frac. | Tenths | Frac. | Tenths | Frac. | Tenths | Frac |
|---|---|---|---|---|---|---|---|---|---|
| ·1 | ·0815 | ·3 | ·24 | ·5 | ·40 | ·7 | ·57 | ·9 | ·73 |
| ·2 | ·16 | ·4 | ·32 | ·6 | ·489 | ·8 | ·65 | | |

## TABLE *for* CALCULATING *the* NET BUSHELS OF MALT.

*(Continued.)*

| Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 229·01 | 331 | 269·76 | 381 | 310·51 | 431 | 351·26 | 481 | 392·01 | 531 | 432·76 | 581 | 473·51 |
| 229·83 | 2 | 270·58 | 2 | 311·33 | 2 | 352·08 | 2 | 392·83 | 2 | 433·58 | 2 | 474·33 |
| 230·64 | 3 | 271·39 | 3 | 312·14 | 3 | 352·89 | 3 | 393·64 | 3 | 434·39 | 3 | 475·14 |
| 231·46 | 4 | 272·21 | 4 | 312·96 | 4 | 353·71 | 4 | 394·46 | 4 | 435·21 | 4 | 475·96 |
| 232·27 | 5 | 273·02 | 5 | 313·77 | 5 | 354·52 | 5 | 395·27 | 5 | 436·02 | 5 | 476·77 |
| 233·09 | 6 | 273·84 | 6 | 314·59 | 6 | 355·34 | 6 | 396·09 | 6 | 436·84 | 6 | 477·59 |
| 233·90 | 7 | 274·65 | 7 | 315·40 | 7 | 356·15 | 7 | 396·90 | 7 | 437·65 | 7 | 478·40 |
| 234·72 | 8 | 275·47 | 8 | 316·22 | 8 | 356·97 | 8 | 397·72 | 8 | 438·47 | 8 | 479·22 |
| 235·53 | 9 | 276·28 | 9 | 317·03 | 9 | 357·78 | 9 | 398·53 | 9 | 439·28 | 9 | 480·03 |
| 236.35 | 340 | 277·10 | 390 | 317·85 | 440 | 358·60 | 490 | 399·35 | 540 | 440·10 | 590 | 480·85 |
| 237·16 | 1 | 277·91 | 1 | 318·66 | 1 | 359·41 | 1 | 400·16 | 1 | 440·91 | 1 | 481·66 |
| 237·98 | 2 | 278·73 | 2 | 319·48 | 2 | 360·23 | 2 | 400·98 | 2 | 441·73 | 2 | 482·48 |
| 238·79 | 3 | 279·54 | 3 | 320·29 | 3 | 361·04 | 3 | 401·79 | 3 | 442·54 | 3 | 483·29 |
| 239·61 | 4 | 280·36 | 4 | 321·11 | 4 | 361·86 | 4 | 402·61 | 4 | 443·36 | 4 | 484·11 |
| 240·42 | 5 | 281·17 | 5 | 321·92 | 5 | 362·67 | 5 | 403·42 | 5 | 444·17 | 5 | 484·92 |
| 241·24 | 6 | 281·99 | 6 | 322·74 | 6 | 363·49 | 6 | 404·24 | 6 | 444·99 | 6 | 485·74 |
| 242·05 | 7 | 282·80 | 7 | 323·55 | 7 | 364·30 | 7 | 405·05 | 7 | 445·80 | 7 | 486·55 |
| 242·87 | 8 | 283·62 | 8 | 324·37 | 8 | 365·12 | 8 | 405·87 | 8 | 446·62 | 8 | 487·37 |
| 243·68 | 9 | 284·43 | 9 | 325·18 | 9 | 365·93 | 9 | 406·68 | 9 | 447·43 | 9 | 488·18 |
| 244·50 | 350 | 285·25 | 400 | 326·00 | 450 | 366·75 | 500 | 407·50 | 550 | 448·25 | 600 | 489·00 |
| 245·31 | 1 | 286·06 | 1 | 326·81 | 1 | 367·56 | 1 | 408·31 | 1 | 449·06 | 1 | 489·81 |
| 246·13 | 2 | 286·88 | 2 | 327·63 | 2 | 368·38 | 2 | 409·13 | 2 | 449·88 | 2 | 490·63 |
| 246·94 | 3 | 287·69 | 3 | 328·44 | 3 | 369·19 | 3 | 409·94 | 3 | 450·69 | 3 | 491·44 |
| 247·76 | 4 | 288·51 | 4 | 329·26 | 4 | 370·01 | 4 | 410·76 | 4 | 451·51 | 4 | 492·26 |
| 248·57 | 5 | 289·32 | 5 | 330·07 | 5 | 370·82 | 5 | 411·57 | 5 | 452·32 | 5 | 493·07 |
| 249·39 | 6 | 290·14 | 6 | 330·89 | 6 | 371·64 | 6 | 412·39 | 6 | 453·14 | 6 | 493·89 |
| 250·20 | 7 | 290·95 | 7 | 331·70 | 7 | 372·45 | 7 | 413·20 | 7 | 453·95 | 7 | 494·70 |
| 251·02 | 8 | 291·77 | 8 | 332·52 | 8 | 373·27 | 8 | 414·02 | 8 | 454·77 | 8 | 495·52 |
| 251·83 | 9 | 292·58 | 9 | 333·33 | 9 | 374·08 | 9 | 414·83 | 9 | 455·58 | 9 | 496·33 |
| 252·65 | 360 | 293·40 | 410 | 334·15 | 460 | 374·90 | 510 | 415·65 | 560 | 456·40 | 610 | 497·15 |
| 253·46 | 1 | 294·21 | 1 | 334·96 | 1 | 375·71 | 1 | 416·46 | 1 | 457·21 | 1 | 497·96 |
| 254·28 | 2 | 295·03 | 2 | 335·78 | 2 | 376·53 | 2 | 417·28 | 2 | 458·03 | 2 | 498·78 |
| 255·09 | 3 | 295·84 | 3 | 336·59 | 3 | 377·34 | 3 | 418·09 | 3 | 458·84 | 3 | 499·59 |
| 255·91 | 4 | 296·66 | 4 | 337·41 | 4 | 378·16 | 4 | 418·91 | 4 | 459·66 | 4 | 500·41 |
| 256·72 | 5 | 297·47 | 5 | 338·22 | 5 | 378·97 | 5 | 419·72 | 5 | 460·47 | 5 | 501·22 |
| 257·54 | 6 | 298·29 | 6 | 339·04 | 6 | 379·79 | 6 | 420·54 | 6 | 461·29 | 6 | 502·04 |
| 258·35 | 7 | 299·10 | 7 | 339·85 | 7 | 380·60 | 7 | 421·35 | 7 | 462·10 | 7 | 502·85 |
| 259·17 | 8 | 299·92 | 8 | 340·67 | 8 | 381·42 | 8 | 422·17 | 8 | 462·92 | 8 | 503·67 |
| 259·98 | 9 | 300·73 | 9 | 341·48 | 9 | 382·23 | 9 | 422·98 | 9 | 463·73 | 9 | 504·48 |
| 260·80 | 370 | 301·55 | 420 | 342·30 | 470 | 383·05 | 520 | 423·80 | 570 | 464·55 | 620 | 505·30 |
| 261·61 | 1 | 302·36 | 1 | 343·11 | 1 | 383·86 | 1 | 424·61 | 1 | 465·36 | 1 | 506·11 |
| 262·43 | 2 | 303·18 | 2 | 343·93 | 2 | 384·68 | 2 | 425·43 | 2 | 466·18 | 2 | 506·93 |
| 263·24 | 3 | 303·99 | 3 | 344·74 | 3 | 385·49 | 3 | 426·24 | 3 | 466·99 | 3 | 507·74 |
| 264·06 | 4 | 304·81 | 4 | 345·56 | 4 | 386·31 | 4 | 427·06 | 4 | 467·81 | 4 | 508·56 |
| 264·87 | 5 | 305·62 | 5 | 346·37 | 5 | 387·12 | 5 | 427·87 | 5 | 468·62 | 5 | 509·37 |
| 265·69 | 6 | 306·44 | 6 | 347·19 | 6 | 387·94 | 6 | 428·69 | 6 | 469·44 | 650 | 529·75 |
| 266·50 | 7 | 307·25 | 7 | 348·00 | 7 | 388·75 | 7 | 429·50 | 7 | 470·25 | 700 | 570·50 |
| 267·32 | 8 | 308·07 | 8 | 348·82 | 8 | 389·57 | 8 | 430·32 | 8 | 471·07 | 800 | 652·00 |
| 268·13 | 9 | 308·88 | 9 | 349·63 | 9 | 390·38 | 9 | 431·13 | 9 | 471·88 | 900 | 733·50 |
| 268·95 | 380 | 309·70 | 430 | 350·45 | 480 | 391·20 | 530 | 431·95 | 580 | 472·70 | 1000 | 815·00 |

## 7 *Gauging Tables.*

### No. I.

### TABLE *for* CALCULATING *the* NET BUSHELS OF MALT *requir* *to be entered on the specimen immediately over the first gauge in t* Couch.—See Board's Order. 1st. Nov. 1836.

By Mr. J. WILD, Supervisor. Ipswich.

| Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·815 | 41 | 33·41 | 81 | 66·01 | 121 | 98·61 | 161 | 131·21 | 201 | 163·81 | 241 |
| 2 | 1·63 | 2 | 34·23 | 2 | 66·83 | 2 | 99·43 | 2 | 132·03 | 2 | 164·63 | 2 |
| 3 | 2·44 | 3 | 35·04 | 3 | 67·64 | 3 | 100·24 | 3 | 132·84 | 3 | 165·44 | 3 |
| 4 | 3·26 | 4 | 35·86 | 4 | 68·46 | 4 | 101·06 | 4 | 133·66 | 4 | 166·26 | 4 |
| 5 | 4·07 | 5 | 36·67 | 5 | 69·27 | 5 | 101·87 | 5 | 134·47 | 5 | 167·07 | 5 |
| 6 | 4·89 | 6 | 37·49 | 6 | 70·09 | 6 | 102·69 | 6 | 135·29 | 6 | 167·89 | 6 |
| 7 | 5·70 | 7 | 38·30 | 7 | 70·90 | 7 | 103·50 | 7 | 136·10 | 7 | 168·70 | 7 |
| 8 | 6·52 | 8 | 39·12 | 8 | 71·72 | 8 | 104·32 | 8 | 136·92 | 8 | 169·52 | 8 |
| 9 | 7·33 | 9 | 39·93 | 9 | 72·53 | 9 | 105·13 | 9 | 137·73 | 9 | 170·33 | 9 |
| 10 | 8·15 | 50 | 40·75 | 90 | 73·35 | 130 | 105·95 | 170 | 138·55 | 210 | 171·15 | 250 |
| 11 | 8·96 | 1 | 41·56 | 1 | 74·16 | 1 | 106·76 | 1 | 139·36 | 1 | 171·96 | 1 |
| 12 | 9·78 | 2 | 42·38 | 2 | 74·98 | 2 | 107·58 | 2 | 140·18 | 2 | 172·78 | 2 |
| 13 | 10·59 | 3 | 43·19 | 3 | 75·79 | 3 | 108·39 | 3 | 140·99 | 3 | 173·59 | 3 |
| 14 | 11·41 | 4 | 44·01 | 4 | 76·61 | 4 | 109·21 | 4 | 141·81 | 4 | 174·41 | 4 |
| 15 | 12·22 | 5 | 44·82 | 5 | 77·42 | 5 | 110·02 | 5 | 142·62 | 5 | 175·22 | 5 |
| 16 | 13·04 | 6 | 45·64 | 6 | 78·24 | 6 | 110·84 | 6 | 143·44 | 6 | 176·04 | 6 |
| 17 | 13·85 | 7 | 46·45 | 7 | 79·05 | 7 | 111·65 | 7 | 144·25 | 7 | 176·85 | 7 |
| 18 | 14·67 | 8 | 47·27 | 8 | 79·87 | 8 | 112·47 | 8 | 145·07 | 8 | 177·67 | 8 |
| 19 | 15·48 | 9 | 48·08 | 9 | 80·68 | 9 | 113·28 | 9 | 145·88 | 9 | 178·48 | 9 |
| 20 | 16·30 | 60 | 48·90 | 100 | 81·50 | 140 | 114·10 | 180 | 146·70 | 220 | 179·30 | 260 |
| 1 | 17·11 | 1 | 49·71 | 1 | 82·31 | 1 | 114·91 | 1 | 147·51 | 1 | 180·11 | 1 |
| 2 | 17·93 | 2 | 50·53 | 2 | 83·13 | 2 | 115·73 | 2 | 148·33 | 2 | 180·93 | 2 |
| 3 | 18·74 | 3 | 51·34 | 3 | 83·94 | 3 | 116·54 | 3 | 149·14 | 3 | 181·74 | 3 |
| 4 | 19·56 | 4 | 52·16 | 4 | 84·76 | 4 | 117·36 | 4 | 149·96 | 4 | 182·56 | 4 |
| 5 | 20·37 | 5 | 52·97 | 5 | 85·57 | 5 | 118·17 | 5 | 150·77 | 5 | 183·37 | 5 |
| 6 | 21·19 | 6 | 53·79 | 6 | 86·39 | 6 | 118·99 | 6 | 151·59 | 6 | 184·19 | 6 |
| 7 | 22·00 | 7 | 54·60 | 7 | 87·20 | 7 | 119·80 | 7 | 152·40 | 7 | 185·00 | 7 |
| 8 | 22·82 | 8 | 55·42 | 8 | 88·02 | 8 | 120·62 | 8 | 153·22 | 8 | 185·82 | 8 |
| 9 | 23·63 | 9 | 56·23 | 9 | 88·83 | 9 | 121·43 | 9 | 154·03 | 9 | 186·63 | 9 |
| 30 | 24·45 | 70 | 57·05 | 110 | 89·65 | 150 | 122·25 | 190 | 154·85 | 230 | 187·45 | 270 |
| 1 | 25·26 | 1 | 57·86 | 1 | 90·46 | 1 | 123·06 | 1 | 155·66 | 1 | 188·26 | |
| 2 | 26·08 | 2 | 58·68 | 2 | 91·28 | 2 | 123·88 | 2 | 156·48 | 2 | [illegible] | |
| 3 | 26·89 | 3 | 59·49 | 3 | 92·09 | 3 | 124·69 | 3 | 157·29 | | | |
| 4 | 27·71 | 4 | 60·31 | 4 | 92·91 | 4 | 125·51 | 4 | [illegible] | | | |
| 5 | 28·52 | 5 | 61·12 | 5 | 93·72 | 5 | 126·32 | 5 | | | | |
| 6 | 29·34 | 6 | 61·94 | 6 | [illegible] | 6 | 127·14 | | | | | |
| 7 | 30·15 | 7 | 62·75 | 7 | [illegible] | 7 | 127·95 | | | | | |
| 8 | 30·97 | 8 | [illegible] | 8 | [illegible] | 8 | [illegible] | | | | | |
| 9 | [illegible] | 9 | [illegible] | 9 | [illegible] | | | | | | | |

TABLE *for* CALCULATING *the* [illegible]

(*Continued.*)

| [illegible] | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ·01 | 331 | 269·76 | 381 | 310·51 | 431 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·83 | 2 | 270·58 | 2 | 311·33 | 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·64 | 3 | 271·39 | 3 | 312·14 | 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·46 | 4 | 272·21 | 4 | 312·96 | 4 | [illegible] | 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·27 | 5 | 273·02 | 5 | 313·77 | 5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·09 | 6 | 273·84 | 6 | 314·59 | 6 | [illegible] | 6 | [illegible] | [illegible] | [illegible] | 6 | [illegible] |
| ·90 | 7 | 274·65 | 7 | 315·40 | 7 | [illegible] | 7 | [illegible] | [illegible] | [illegible] | 7 | [illegible] |
| ·72 | 8 | 275·47 | 8 | 316·22 | 8 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·53 | 9 | 276·28 | 9 | 317·03 | 9 | [illegible] | 9 | [illegible] | 9 | [illegible] | 9 | [illegible] |
| ·35 | 340 | 277·10 | 390 | 317·85 | 440 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 7·16 | 1 | 277·91 | 1 | 318·66 | 1 | 359·41 | 1 | [illegible] | 1 | [illegible] | 1 | 481·66 |
| 7·98 | 2 | 278·73 | 2 | 319·48 | 2 | 360·23 | 2 | [illegible] | 2 | [illegible] | 2 | 482·48 |
| 8·79 | 3 | 279·54 | 3 | 320·29 | 3 | 361·04 | 3 | 401·79 | 3 | [illegible] | [illegible] | [illegible] |
| ·61 | 4 | 280·36 | 4 | 321·11 | 4 | 361·86 | 4 | 402·61 | 4 | [illegible] | [illegible] | [illegible] |
| ·42 | 5 | 281·17 | 5 | 321·92 | 5 | 362·67 | 5 | 403·42 | 5 | [illegible] | [illegible] | [illegible] |
| 1·24 | 6 | 281·99 | 6 | 322·74 | 6 | 363·49 | 6 | 404·24 | 6 | [illegible] | [illegible] | 485·74 |
| ·05 | 7 | 282·80 | 7 | 323·55 | 7 | 364·30 | 7 | 405·05 | 7 | [illegible] | [illegible] | 486·55 |
| ·87 | 8 | 283·62 | 8 | 324·37 | 8 | 365·12 | 8 | [illegible] | [illegible] | [illegible] | [illegible] | 487·37 |
| 43·68 | 9 | 284·43 | 9 | 325·18 | 9 | 365·93 | 9 | [illegible] | [illegible] | [illegible] | 9 | 488·18 |
| 44·50 | 350 | 285·25 | 400 | 326·00 | 450 | 366·75 | 500 | [illegible] | [illegible] | [illegible] | 600 | 489·00 |
| 45·31 | 1 | 286·06 | 1 | 326·81 | 1 | 367·56 | 1 | [illegible] | [illegible] | [illegible] | 1 | 489·81 |
| 46·13 | 2 | 286·88 | 2 | 327·63 | 2 | 368·38 | [illegible] | [illegible] | [illegible] | [illegible] | 2 | [illegible] |
| 46·94 | 3 | 287·69 | 3 | 328·44 | 3 | 369·19 | [illegible] | [illegible] | [illegible] | [illegible] | 3 | [illegible] |
| 47·76 | 4 | 288·51 | 4 | 329·26 | 4 | 370·01 | [illegible] | [illegible] | [illegible] | [illegible] | 4 | [illegible] |
| 48·57 | 5 | 289·32 | 5 | 330·07 | 5 | 370·82 | [illegible] | [illegible] | [illegible] | [illegible] | 5 | [illegible] |
| 49·39 | 6 | 290·14 | 6 | 330·89 | 6 | 371·64 | [illegible] | [illegible] | [illegible] | [illegible] | 6 | [illegible] |
| 50·20 | 7 | 290·95 | 7 | 331·70 | 7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 7 | [illegible] |
| 51·02 | 8 | 291·77 | 8 | 332·52 | 8 | [illegible] | [illegible] | [illegible] | [illegible] | 454·77 | 8 | [illegible] |
| 51·83 | 9 | 292·58 | 9 | 333·33 | 9 | [illegible] | [illegible] | [illegible] | [illegible] | 455·58 | [illegible] | [illegible] |
| 52·65 | 360 | 293·40 | 410 | 334·15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 456·40 | [illegible] | [illegible] |
| 53·46 | 1 | 294·21 | 1 | 334·96 | 1 | [illegible] | [illegible] | [illegible] | [illegible] | 457·21 | [illegible] | [illegible] |
| 54·28 | 2 | 295·03 | 2 | [illegible] | 2 | [illegible] | [illegible] | [illegible] | 2 | 458·03 | [illegible] | [illegible] |
| 55·09 | 3 | 295·84 | 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3 | 458·84 | [illegible] | [illegible] |
| 55·91 | 4 | 296·66 | 4 | [illegible] | 4 | [illegible] | [illegible] | [illegible] | 4 | [illegible] | [illegible] | [illegible] |
| 56·72 | 5 | 297·47 | 5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 57·54 | 6 | 298·29 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 58·35 | 7 | 299·10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 59·17 | 8 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 59·98 | 9 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 260·80 | 370 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 261·61 | 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 262·43 | 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 263·24 | 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 264·06 | 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 264·87 | 5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ·69 | 6 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

## 7 *Gauging Tables.*

### No. 1.

TABLE *for* CALCULATING *the* NET BUSHELS OF MALT *required to be entered on the specimen immediately over the first gauge in the Couch.*—See Board's Order. 1st. Nov. 1836.

By Mr. J. WILD, Supervisor. Ipswich.

| Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·815 | 41 | 33·41 | 81 | 66·01 | 121 | 98·61 | 161 | 131·21 | 201 | 163·81 | 241 | 196·41 |
| 2 | 1·63 | 2 | 34·23 | 2 | 66·83 | 2 | 99·43 | 2 | 132·03 | 2 | 164·63 | 2 | 197·2 |
| 3 | 2·44 | 3 | 35·04 | 3 | 67·64 | 3 | 100·24 | 3 | 132·84 | 3 | 165·44 | 3 | 198·04 |
| 4 | 3·26 | 4 | 35·86 | 4 | 68·46 | 4 | 101·06 | 4 | 133·66 | 4 | 166·26 | 4 | 198·8 |
| 5 | 4·07 | 5 | 36·67 | 5 | 69·27 | 5 | 101·87 | 5 | 134·47 | 5 | 167·07 | 5 | 199·6 |
| 6 | 4·89 | 6 | 37·49 | 6 | 70·09 | 6 | 102·69 | 6 | 135·29 | 6 | 167·89 | 6 | 200·4 |
| 7 | 5·70 | 7 | 38·30 | 7 | 70·90 | 7 | 103·50 | 7 | 136·10 | 7 | 168·70 | 7 | 201·3 |
| 8 | 6·52 | 8 | 39·12 | 8 | 71·72 | 8 | 104·32 | 8 | 136·92 | 8 | 169·52 | 8 | 202·1 |
| 9 | 7·33 | 9 | 39·93 | 9 | 72·53 | 9 | 105·13 | 9 | 137·73 | 9 | 170·33 | 9 | 202·9 |
| 10 | 8·15 | 50 | 40·75 | 90 | 73·35 | 130 | 105·95 | 170 | 138·55 | 210 | 171·15 | 250 | 203·7 |
| 11 | 8·96 | 1 | 41·56 | 1 | 74·16 | 1 | 106·76 | 1 | 139·36 | 1 | 171·96 | 1 | 204·5 |
| 12 | 9·78 | 2 | 42·38 | 2 | 74·98 | 2 | 107·58 | 2 | 140·18 | 2 | 172·78 | 2 | 205·3 |
| 13 | 10·59 | 3 | 43·19 | 3 | 75·79 | 3 | 108·39 | 3 | 140·99 | 3 | 173·59 | 3 | 206·1 |
| 14 | 11·41 | 4 | 44·01 | 4 | 76·61 | 4 | 109·21 | 4 | 141·81 | 4 | 174·41 | 4 | 207·01 |
| 15 | 12·22 | 5 | 44·82 | 5 | 77·42 | 5 | 110·02 | 5 | 142·62 | 5 | 175·22 | 5 | 207·8 |
| 16 | 13·04 | 6 | 45·64 | 6 | 78·24 | 6 | 110·84 | 6 | 143·44 | 6 | 176·04 | 6 | 208·64 |
| 17 | 13·85 | 7 | 46·45 | 7 | 79·05 | 7 | 111·65 | 7 | 144·25 | 7 | 176·85 | 7 | 209·4 |
| 18 | 14·67 | 8 | 47·27 | 8 | 79·87 | 8 | 112·47 | 8 | 145·07 | 8 | 177·67 | 8 | 210·2 |
| 19 | 15·48 | 9 | 48·08 | 9 | 80·68 | 9 | 113·28 | 9 | 145·88 | 9 | 178·48 | 9 | 211·0 |
| 20 | 16·30 | 60 | 48·90 | 100 | 81·50 | 140 | 114·10 | 180 | 146·70 | 220 | 179·30 | 260 | 211·9 |
| 1 | 17·11 | 1 | 49·71 | 1 | 82·31 | 1 | 114·91 | 1 | 147·51 | 1 | 180·11 | 1 | 212·7 |
| 2 | 17·93 | 2 | 50·53 | 2 | 83·13 | 2 | 115·73 | 2 | 148·33 | 2 | 180·93 | 2 | 213·5 |
| 3 | 18·74 | 3 | 51·34 | 3 | 83·94 | 3 | 116·54 | 3 | 149·14 | 3 | 181·74 | 3 | 214·3 |
| 4 | 19·56 | 4 | 52·16 | 4 | 84·76 | 4 | 117·36 | 4 | 149·96 | 4 | 182·56 | 4 | 215·16 |
| 5 | 20·37 | 5 | 52·97 | 5 | 85·57 | 5 | 118·17 | 5 | 150·77 | 5 | 183·37 | 5 | 215·97 |
| 6 | 21·19 | 6 | 53·79 | 6 | 86·39 | 6 | 118·99 | 6 | 151·59 | 6 | 184·19 | 6 | 216·7 |
| 7 | 22·00 | 7 | 54·60 | 7 | 87·20 | 7 | 119·80 | 7 | 152·40 | 7 | 185·00 | 7 | 217·60 |
| 8 | 22·82 | 8 | 55·42 | 8 | 88·02 | 8 | 120·62 | 8 | 153·22 | 8 | 185·82 | 8 | 218·42 |
| 9 | 23·63 | 9 | 56·23 | 9 | 88·83 | 9 | 121·43 | 9 | 154·03 | 9 | 186·63 | 9 | 219·2 |
| 30 | 24·45 | 70 | 57·05 | 110 | 89·65 | 150 | 122·25 | 190 | 154·85 | 230 | 187·45 | 270 | 220·0 |
| 1 | 25·26 | 1 | 57·86 | 1 | 90·46 | 1 | 123·06 | 1 | 155·66 | 1 | 188·26 | 1 | 220·8 |
| 2 | 26·08 | 2 | 58·68 | 2 | 91·28 | 2 | 123·88 | 2 | 156·48 | 2 | 189·08 | 2 | 221·6 |
| 3 | 26·89 | 3 | 59·49 | 3 | 92·09 | 3 | 124·69 | 3 | 157·29 | 3 | 189·89 | 3 | 222·49 |
| 4 | 27·71 | 4 | 60·31 | 4 | 92·91 | 4 | 125·51 | 4 | 158·11 | 4 | 190·71 | 4 | 223·31 |
| 5 | 28·52 | 5 | 61·12 | 5 | 93·72 | 5 | 126·32 | 5 | 158·92 | 5 | 191·52 | 5 | 224·12 |
| 6 | 29·34 | 6 | 61·94 | 6 | 94·54 | 6 | 127·14 | 6 | 159·74 | 6 | 192·34 | 6 | 224·94 |
| 7 | 30·15 | 7 | 62·75 | 7 | 95·35 | 7 | 127·95 | 7 | 160·55 | 7 | 193·15 | 7 | 225·75 |
| 8 | 30·97 | 8 | 63·57 | 8 | 96·17 | 8 | 128·77 | 8 | 161·37 | 8 | 193·97 | 8 | 226·57 |
| 9 | 31·78 | 9 | 64·38 | 9 | 96·98 | 9 | 129·58 | 9 | 162·18 | 9 | 194·78 | 9 | 227·38 |
| 40 | 32·60 | 80 | 65·20 | 120 | 97·80 | 160 | 130·40 | 200 | 163·00 | 240 | 195·60 | 280 | 228·20 |

| Tenths | Frac. | Tenths | Frac. | Tenths | Frac. | Tenths | Frac. | Tenths | Frac. |
|---|---|---|---|---|---|---|---|---|---|
| ·1 | ·0815 | ·3 | ·24 | ·5 | ·40 | ·7 | ·57 | ·9 | ·73 |
| ·2 | ·16 | ·4 | ·32 | ·6 | ·489 | ·8 | ·65 | | |

## TABLE *for* CALCULATING *the* NET BUSHELS OF MALT.

*(Continued.)*

| Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. | Gross Bushels. | Net Bus. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 229·01 | 331 | 269·76 | 381 | 310·51 | 431 | 351·26 | 481 | 392·01 | 531 | 432·76 | 581 | 473·51 |
| 2 | 229·83 | 2 | 270·58 | 2 | 311·33 | 2 | 352·08 | 2 | 392·83 | 2 | 433·58 | 2 | 474·33 |
| 3 | 230·64 | 3 | 271·39 | 3 | 312·14 | 3 | 352·89 | 3 | 393·64 | 3 | 434·39 | 3 | 475·14 |
| 4 | 231·46 | 4 | 272·21 | 4 | 312·96 | 4 | 353·71 | 4 | 394·46 | 4 | 435·21 | 4 | 475·96 |
| 5 | 232·27 | 5 | 273·02 | 5 | 313·77 | 5 | 354·52 | 5 | 395·27 | 5 | 436·02 | 5 | 476·77 |
| 6 | 233·09 | 6 | 273·84 | 6 | 314·59 | 6 | 355·34 | 6 | 396·09 | 6 | 436·84 | 6 | 477·59 |
| 7 | 233·90 | 7 | 274·65 | 7 | 315·40 | 7 | 356·15 | 7 | 396·90 | 7 | 437·65 | 7 | 478·40 |
| 8 | 234·72 | 8 | 275·47 | 8 | 316·22 | 8 | 356·97 | 8 | 397·72 | 8 | 438·47 | 8 | 479·22 |
| 9 | 235·53 | 9 | 276·28 | 9 | 317·03 | 9 | 357·78 | 9 | 398·53 | 9 | 439·28 | 9 | 480·03 |
| 90 | 236.35 | 340 | 277·10 | 390 | 317·85 | 440 | 358·60 | 490 | 399·35 | 540 | 440·10 | 590 | 480·85 |
| 1 | 237·16 | 1 | 277·91 | 1 | 318·66 | 1 | 359·41 | 1 | 400·16 | 1 | 440·91 | 1 | 481·66 |
| 2 | 237·98 | 2 | 278·73 | 2 | 319·48 | 2 | 360·23 | 2 | 400·98 | 2 | 441·73 | 2 | 482·48 |
| 3 | 238·79 | 3 | 279·54 | 3 | 320·29 | 3 | 361·04 | 3 | 401·79 | 3 | 442·54 | 3 | 483·29 |
| 4 | 239·61 | 4 | 280·36 | 4 | 321·11 | 4 | 361·86 | 4 | 402·61 | 4 | 443·36 | 4 | 484·11 |
| 5 | 240·42 | 5 | 281·17 | 5 | 321·92 | 5 | 362·67 | 5 | 403·42 | 5 | 444·17 | 5 | 484·92 |
| 6 | 241·24 | 6 | 281·99 | 6 | 322·74 | 6 | 363·49 | 6 | 404·24 | 6 | 444·99 | 6 | 485·74 |
| 7 | 242·05 | 7 | 282·80 | 7 | 323·55 | 7 | 364·30 | 7 | 405·05 | 7 | 445·80 | 7 | 486·55 |
| 8 | 242·87 | 8 | 283·62 | 8 | 324·37 | 8 | 365·12 | 8 | 405·87 | 8 | 446·62 | 8 | 487·37 |
| 9 | 243·68 | 9 | 284·43 | 9 | 325·18 | 9 | 365·93 | 9 | 406·68 | 9 | 447·43 | 9 | 488·18 |
| 00 | 244·50 | 350 | 285·25 | 400 | 326·00 | 450 | 366·75 | 500 | 407·50 | 550 | 448·25 | 600 | 489·00 |
| 1 | 245·31 | 1 | 286·06 | 1 | 326·81 | 1 | 367·56 | 1 | 408·31 | 1 | 449·06 | 1 | 489·81 |
| 2 | 246·13 | 2 | 286·88 | 2 | 327·63 | 2 | 368·38 | 2 | 409·13 | 2 | 449·88 | 2 | 490·63 |
| 3 | 246·94 | 3 | 287·69 | 3 | 328·44 | 3 | 369·19 | 3 | 409·94 | 3 | 450·69 | 3 | 491·44 |
| 4 | 247·76 | 4 | 288·51 | 4 | 329·26 | 4 | 370·01 | 4 | 410·76 | 4 | 451·51 | 4 | 492·26 |
| 5 | 248·57 | 5 | 289·32 | 5 | 330·07 | 5 | 370·82 | 5 | 411·57 | 5 | 452·32 | 5 | 493·07 |
| 6 | 249·39 | 6 | 290·14 | 6 | 330·89 | 6 | 371·64 | 6 | 412·39 | 6 | 453·14 | 6 | 493·89 |
| 7 | 250·20 | 7 | 290·95 | 7 | 331·70 | 7 | 372·45 | 7 | 413·20 | 7 | 453·95 | 7 | 494·70 |
| 8 | 251·02 | 8 | 291·77 | 8 | 332·52 | 8 | 373·27 | 8 | 414·02 | 8 | 454·77 | 8 | 495·52 |
| 9 | 251·83 | 9 | 292·58 | 9 | 333·33 | 9 | 374·08 | 9 | 414·83 | 9 | 455·58 | 9 | 496·33 |
| 10 | 252·65 | 360 | 293·40 | 410 | 334·15 | 460 | 374·90 | 510 | 415·65 | 560 | 456·40 | 610 | 497·15 |
| 1 | 253·46 | 1 | 294·21 | 1 | 334·96 | 1 | 375·71 | 1 | 416·46 | 1 | 457·21 | 1 | 497·96 |
| 2 | 254·28 | 2 | 295·03 | 2 | 335·78 | 2 | 376·53 | 2 | 417·28 | 2 | 458·03 | 2 | 498·78 |
| 3 | 255·09 | 3 | 295·84 | 3 | 336·59 | 3 | 377·34 | 3 | 418·09 | 3 | 458·84 | 3 | 499·59 |
| 4 | 255·91 | 4 | 296·66 | 4 | 337·41 | 4 | 378·16 | 4 | 418·91 | 4 | 459·66 | 4 | 500·41 |
| 5 | 256·72 | 5 | 297·47 | 5 | 338·22 | 5 | 378·97 | 5 | 419·72 | 5 | 460·47 | 5 | 501·22 |
| 6 | 257·54 | 6 | 298·29 | 6 | 339·04 | 6 | 379·79 | 6 | 420·54 | 6 | 461·29 | 6 | 502·04 |
| 7 | 258·35 | 7 | 299·10 | 7 | 339·85 | 7 | 380·60 | 7 | 421·35 | 7 | 462·10 | 7 | 502·85 |
| 8 | 259·17 | 8 | 299·92 | 8 | 340·67 | 8 | 381·42 | 8 | 422·17 | 8 | 462·92 | 8 | 503·67 |
| 9 | 259·98 | 9 | 300·73 | 9 | 341·48 | 9 | 382·23 | 9 | 422·98 | 9 | 463·73 | 9 | 504·48 |
| 20 | 260·80 | 370 | 301·55 | 420 | 342·30 | 470 | 383·05 | 520 | 423·80 | 570 | 464·55 | 620 | 505·30 |
| 1 | 261·61 | 1 | 302·36 | 1 | 343·11 | 1 | 383·86 | 1 | 424·61 | 1 | 465·36 | 1 | 506·11 |
| 2 | 262·43 | 2 | 303·18 | 2 | 343·93 | 2 | 384·68 | 2 | 425·43 | 2 | 466·18 | 2 | 506·93 |
| 3 | 263·24 | 3 | 303·99 | 3 | 344·74 | 3 | 385·49 | 3 | 426·24 | 3 | 466·99 | 3 | 507·74 |
| 4 | 264·06 | 4 | 304·81 | 4 | 345·56 | 4 | 386·31 | 4 | 427·06 | 4 | 467·81 | 4 | 508·56 |
| 5 | 264·87 | 5 | 305·62 | 5 | 346·37 | 5 | 387·12 | 5 | 427·87 | 5 | 468·62 | 5 | 509·37 |
| 6 | 265·69 | 6 | 306·44 | 6 | 347·19 | 6 | 387·94 | 6 | 428·69 | 6 | 469·44 | 650 | 529·75 |
| 7 | 266·50 | 7 | 307·25 | 7 | 348·00 | 7 | 388·75 | 7 | 429·50 | 7 | 470·25 | 700 | 570·50 |
| 8 | 267·32 | 8 | 308·07 | 8 | 348·82 | 8 | 389·57 | 8 | 430·32 | 8 | 471·07 | 800 | 652·00 |
| 9 | 268·13 | 9 | 308·88 | 9 | 349·63 | 9 | 390·38 | 9 | 431·13 | 9 | 471·88 | 900 | 733·50 |
| 30 | 268·95 | 380 | 309·70 | 430 | 350·45 | 480 | 391·20 | 530 | 431·95 | 580 | 472·70 | 1000 | 815·00 |

No. 2. **Table** *shewing the* **Quantity of Water** *necessary to reduce* **Proof Spirits** *to the following strength.*

| Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ⅛ | 1·6 | | 1 | 12·5 | | 1⅞ | 23·4 | 1 | ⅝ | 32·8 | 1 | 1⅜ | 42·2 |
| | ¼ | 3·1 | | 1⅛ | 14·1 | 1 | | 25·0 | 1 | ¾ | 34·4 | 1 | 1½ | 43·8 |
| | ⅜ | 4·7 | | 1¼ | 15·6 | 1 | ⅛ | 26·6 | 1 | ⅞ | 35·9 | 1 | 1⅝ | 45·3 |
| | ½ | 6·2 | | 1⅜ | 17·2 | 1 | ¼ | 28·1 | 1 | 1 | 37·5 | 1 | 1¾ | 46·9 |
| | ⅝ | 7·8 | | 1½ | 18·8 | 1 | ⅜ | 29·7 | 1 | 1⅛ | 39·1 | 1 | 1⅞ | 48·4 |
| | ¾ | 9·4 | | 1⅝ | 20·3 | 1 | ½ | 31·2 | 1 | 1¼ | 40·6 | 2 | | 50·0 |
| | ⅞ | 11·0 | | 1¾ | 21·9 | | | | | | | | | |

*Example.*—If 1⅛ pint of water be put into a gallon measure, and the measure filled up with proof spirit; the spirit will be reduced to 14·1 per cent. u. p.—*Nisbett's Gauging.*

No. 3. **Table** *shewing the* **Quantity of Water** *necessary to reduce* **Spirits** of 22 per cent. u. p. to the following strength.

| Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ⅛ | 23·2 | | 1 | 31·8 | | 1⅞ | 40·3 | 1 | ⅝ | 47·6 | 1 | 1⅜ | 54·9 |
| | ¼ | 24·4 | | 1⅛ | 33·0 | 1 | | 41·5 | 1 | ¾ | 48·8 | 1 | 1½ | 56·1 |
| | ⅜ | 25·7 | | 1¼ | 34·2 | 1 | ⅛ | 42·7 | 1 | ⅞ | 50·0 | 1 | 1⅝ | 57·3 |
| | ½ | 26·9 | | 1⅜ | 35·4 | 1 | ¼ | 43·9 | 1 | 1 | 51·2 | 1 | 1¾ | 58·6 |
| | ⅝ | 28·1 | | 1½ | 36·6 | 1 | ⅜ | 45·2 | 1 | 1⅛ | 52·5 | 1 | 1⅞ | 59·8 |
| | ¾ | 29·3 | | 1⅝ | 37·8 | 1 | ½ | 46·4 | 1 | 1¼ | 53·7 | 2 | | 61·0 |
| | ⅞ | 30·5 | | 1¾ | 39·1 | | | | | | | | | |

*Example.*—If 1¼ pint of water be put into a gallon measure, and the measure be filled up with spirits of 22 per cent. u. p., the spirit will be reduced to 34·2 per cent. u. p.

No. 4. **Table** *shewing the* **Quantity** *of* **Spirits** *of* 22 *u. p. to be added to* **Spirits** *of* 61 *u. p. to raise the strength, as follows:*

| Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. | Quarts. | Pts. | Strength u. p. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ⅛ | 60·4 | | 1¾ | 52·5 | 1 | 1⅜ | 44·5 | 2 | 1 | 36·6 | 3 | ⅝ | 28·7 |
| | ¼ | 59·8 | | 1⅞ | 51·9 | 1 | 1½ | 43·9 | 2 | 1⅛ | 36·0 | 3 | ¾ | 28·1 |
| | ⅜ | 59·2 | 1 | | 51·3 | 1 | 1⅝ | 43·3 | 2 | 1¼ | 35·4 | 3 | ⅞ | 27·5 |
| | ½ | 58·6 | 1 | ⅛ | 50·6 | 1 | 1¾ | 42·7 | 2 | 1⅜ | 34·8 | 3 | 1 | 26·9 |
| | ⅝ | 58·0 | 1 | ¼ | 50·0 | 1 | 1⅞ | 42·1 | 2 | 1½ | 34·2 | 3 | 1⅛ | 26·3 |
| | ¾ | 57·3 | 1 | ⅜ | 49·4 | 2 | | 41·5 | 2 | 1⅝ | 33·6 | 3 | 1¼ | 25·7 |
| | ⅞ | 56·7 | 1 | ½ | 48·8 | 2 | ⅛ | 40·9 | 2 | 1¾ | 33·0 | 3 | 1⅜ | 25·0 |
| | 1 | 56·1 | 1 | ⅝ | 48·2 | 2 | ¼ | 40·3 | 2 | 1⅞ | 32·4 | 3 | 1½ | 24·4 |
| | 1⅛ | 55·5 | 1 | ¾ | 47·6 | 2 | ⅜ | 39·7 | 3 | | 31·8 | 3 | 1⅝ | 23·8 |
| | 1¼ | 54·9 | 1 | ⅞ | 47·0 | 2 | ½ | 39·0 | 3 | ⅛ | 31·1 | 3 | 1¾ | 23·2 |
| | 1⅜ | 54·3 | 1 | 1 | 46·4 | 2 | ⅝ | 38·4 | 3 | ¼ | 30·5 | 3 | 1⅞ | 22·6 |
| | 1½ | 53·7 | 1 | 1⅛ | 45·8 | 2 | ¾ | 37·8 | 3 | ⅜ | 29·9 | 4 | | 22·0 |
| | 1⅝ | 53·1 | 1 | 1¼ | 45·2 | 2 | ⅞ | 37·2 | 3 | ½ | 29·3 | | | |

*Example.*—If 1 quart and ⅛ of a pint of spirits at 22 per cent. u. p. be put into a gallon measure, and such measure filled up with spirits at 61 per cent. u. p., the strength of the spirit will be raised to 50·7 per cent. u. p.

### No. 5.

## TABLE *of a* DIAGONAL LINE *for* CASK GAUGING.

*(See Roose's Guide, p. 12.)*

| Diagonal Line in Inches and decimal parts of an Inch. | Gallons. | Diagonal Line in inches and decimal parts of an Inch. | Gallons. | Diagonal Line in Inches and decimal parts of an Inch. | Gallons. | Diagonal Line in Inches and decimal parts of an Inch. | Gallons. |
|---|---|---|---|---|---|---|---|
| 6·04 | ½ | 28·21 | 51 | 35·42 | 101 | 40·5 | 151 |
| 7·61 | 1 | 28·39 | 52 | 35·54 | 102 | 40·59 | 152 |
| 9·58 | 2 | 28·57 | 53 | 35·65 | 103 | 40·68 | 153 |
| 10·97 | 3 | 28·75 | 54 | 35·77 | 104 | 40·77 | 154 |
| 12·07 | 4 | 28·92 | 55 | 35·88 | 105 | 40·86 | 155 |
| 13·01 | 5 | 29·1 | 56 | 36· | 106 | 40·94 | 156 |
| 13·82 | 6 | 29·27 | 57 | 36·11 | 107 | 41·03 | 157 |
| 14·55 | 7 | 29·44 | 58 | 36·22 | 108 | 41·12 | 158 |
| 15·21 | 8 | 29·61 | 59 | 36·33 | 109 | 41·2 | 159 |
| 15·82 | 9 | 29·78 | 60 | 36·44 | 110 | 41·29 | 160 |
| 16·39 | 10 | 29·94 | 61 | 36·55 | 111 | 41·38 | 161 |
| 16·92 | 11 | 30·1 | 62 | 36·66 | 112 | 41·46 | 162 |
| 17·41 | 12 | 30·26 | 63 | 36·77 | 113 | 41·55 | 163 |
| 17·88 | 13 | 30·42 | 64 | 36·88 | 114 | 41·63 | 164 |
| 18·33 | 14 | 30·58 | 65 | 36·99 | 115 | 41·72 | 165 |
| 18·76 | 15 | 30·74 | 66 | 37·09 | 116 | 41·8 | 166 |
| 19·17 | 16 | 30·89 | 67 | 37·2 | 117 | 41·88 | 167 |
| 19·56 | 17 | 31·04 | 68 | 37·3 | 118 | 41·97 | 168 |
| 19·93 | 18 | 31·2 | 69 | 37·41 | 119 | 42·05 | 169 |
| 20·3 | 19 | 31·35 | 70 | 37·52 | 120 | 42·14 | 170 |
| 20·65 | 20 | 31·49 | 71 | 37·62 | 121 | 42·21 | 171 |
| 20·98 | 21 | 31·64 | 72 | 37·72 | 122 | 42·3 | 172 |
| 21·31 | 22 | 31·79 | 73 | 37·82 | 123 | 42·38 | 173 |
| 21·63 | 23 | 31·93 | 74 | 37·93 | 124 | 42·46 | 174 |
| 21·95 | 24 | 32·08 | 75 | 38·03 | 125 | 42·54 | 175 |
| 22·24 | 25 | 32·22 | 76 | 38·13 | 126 | 42·62 | 176 |
| 22·53 | 26 | 32·36 | 77 | 38·23 | 127 | 42·7 | 177 |
| 22·82 | 27 | 32·5 | 78 | 38·33 | 128 | 42·78 | 178 |
| 23·1 | 28 | 32·64 | 79 | 38·43 | 129 | 42·87 | 179 |
| 23·37 | 29 | 32·77 | 80 | 38·53 | 130 | 42·95 | 180 |
| 23·63 | 30 | 32·91 | 81 | 38·63 | 131 | 43·02 | 181 |
| 23·89 | 31 | 33·04 | 82 | 38·73 | 132 | 43·1 | 182 |
| 24·15 | 32 | 33·18 | 83 | 38·83 | 133 | 43·18 | 183 |
| 24·4 | 33 | 33·31 | 84 | 38·92 | 134 | 43·26 | 184 |
| 24·64 | 34 | 33·44 | 85 | 39·02 | 135 | 43·34 | 185 |
| 24·88 | 35 | 33·57 | 86 | 39·11 | 136 | 43·42 | 186 |
| 25·11 | 36 | 33·7 | 87 | 39·21 | 137 | 43·49 | 187 |
| 25·34 | 37 | 33·83 | 88 | 39·3 | 138 | 43·57 | 188 |
| 25·57 | 38 | 33·96 | 89 | 39·4 | 139 | 43·65 | 189 |
| 25·79 | 39 | 34·08 | 90 | 39·49 | 140 | 43·73 | 190 |
| 26·01 | 40 | 34·21 | 91 | 39·59 | 141 | 43·8 | 191 |
| 26·23 | 41 | 34·34 | 92 | 39·68 | 142 | 43·88 | 192 |
| 26·44 | 42 | 34·46 | 93 | 39·77 | 143 | 43·95 | 193 |
| 26·65 | 43 | 34·58 | 94 | 39·87 | 144 | 44·03 | 194 |
| 26·85 | 44 | 34·7 | 95 | 39·96 | 145 | 44·1 | 195 |
| 27·05 | 45 | 34·83 | 96 | 40·05 | 146 | 44·18 | 196 |
| 27·25 | 46 | 34·95 | 97 | 40·14 | 147 | 44·26 | 197 |
| 27·45 | 47 | 35·06 | 98 | 40·23 | 148 | 44·33 | 198 |
| 27·64 | 48 | 35·19 | 99 | 40·32 | 149 | 44·4 | 199 |
| 27·83 | 49 | 35·3 | 100 | 40·41 | 150 | 44·48 | 200 |
| 28·02 | 50 | | | | | | |

### No. 6.

## AREAS *of the* HEAD DIAMETERS *of* CASKS

| Inch. | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | ·0944 | ·0963 | ·0982 | ·1001 | ·1021 | ·1041 | ·1061 | ·1081 | ·1101 | ·1122 |
| 11 | ·1142 | ·1163 | ·1184 | ·1205 | ·1227 | ·1248 | ·1271 | ·1293 | ·1315 | ·1337 |
| 12 | ·1360 | ·1382 | ·1405 | ·1428 | ·1452 | ·1475 | ·1499 | ·1523 | ·1547 | ·1571 |
| 13 | ·1596 | ·1620 | ·1645 | ·1670 | ·1695 | ·1721 | ·1746 | ·1772 | ·1798 | ·1824 |
| 14 | ·1851 | ·1877 | ·1904 | ·1931 | ·1958 | ·1985 | ·2013 | ·2040 | ·2068 | ·2096 |
| 15 | ·2124 | ·2153 | ·2181 | ·2210 | ·2239 | ·2268 | ·2298 | ·2327 | ·2357 | ·2387 |
| 16 | ·2417 | ·2447 | ·2478 | ·2509 | ·2539 | ·2571 | ·2602 | ·2633 | ·2665 | ·2697 |
| 17 | ·2729 | ·2761 | ·2793 | ·2826 | ·2859 | ·2892 | ·2925 | ·2958 | ·2992 | ·3025 |
| 18 | ·3059 | ·3093 | ·3128 | ·3166 | ·3197 | ·3231 | ·3267 | ·3302 | ·3337 | ·3373 |
| 19 | ·3409 | ·3445 | ·3481 | ·3517 | ·3554 | ·3590 | ·3627 | ·3664 | ·3702 | ·3739 |
| 20 | ·3777 | ·3815 | ·3853 | ·3891 | ·3929 | ·3968 | ·4007 | ·4046 | ·4085 | ·4124 |
| 21 | ·4164 | ·4204 | ·4244 | ·4284 | ·4324 | ·4365 | ·4405 | ·4446 | ·4487 | ·4528 |
| 22 | ·4570 | ·4612 | ·4653 | ·4695 | ·4738 | ·4780 | ·4823 | ·4865 | ·4908 | ·4951 |
| 23 | ·4995 | ·5038 | ·5082 | ·5126 | ·5170 | ·5214 | ·5260 | ·5303 | ·5348 | ·5393 |
| 24 | ·5439 | ·5484 | ·5530 | ·5575 | ·5621 | ·5668 | ·5714 | ·5760 | ·5807 | ·5854 |
| 25 | ·5901 | ·5948 | ·5996 | ·6044 | ·6092 | ·6140 | ·6188 | ·6236 | ·6285 | ·6334 |
| 26 | ·6383 | ·6432 | ·6481 | ·6531 | ·6581 | ·6631 | ·6681 | ·6731 | ·6782 | ·6832 |
| 27 | ·6883 | ·6934 | ·6986 | .7037 | ·7089 | ·7140 | ·7192 | ·7245 | ·7297 | ·7350 |
| 28 | ·7402 | ·7455 | ·7509 | .7562 | ·7615 | ·7669 | ·7723 | ·7777 | ·7831 | ·7886 |
| 29 | ·7941 | ·7996 | ·8051 | ·8106 | ·8161 | ·8217 | ·8273 | ·8329 | ·8385 | ·8441 |
| 30 | ·8498 | ·8554 | ·8611 | ·8669 | ·8726 | ·8783 | ·8841 | ·8899 | ·8957 | ·9015 |
| 31 | ·9074 | ·9132 | ·9191 | ·9250 | ·9309 | ·9368 | ·9428 | ·9488 | ·9548 | ·9608 |
| 32 | ·9669 | ·9729 | ·9790 | ·9851 | ·9912 | ·9973 | 1·0034 | 1·0096 | 1·0158 | 1·0220 |
| 33 | 1·0282 | 1·0345 | 1·0407 | 1·0470 | 1·0533 | 1·0596 | 1·0660 | 1·0723 | 1·0787 | 1·0851 |
| 34 | 1·0915 | 1·0979 | 1·1044 | 1·1108 | 1·1173 | 1·1238 | 1·1303 | 1·1369 | 1·1435 | 1·1503 |
| 35 | 1·1566 | 1·1633 | 1·1699 | 1·1765 | 1·1832 | 1·1899 | 1·1966 | 1·2034 | 1·2101 | 1·2169 |
| 36 | 1·2237 | 1·2305 | 1·2373 | 1·2442 | 1·2510 | 1·2579 | 1·2648 | 1·2717 | 1·2737 | 1·2856 |
| 37 | 1·2926 | 1·2996 | 1·3066 | 1·3136 | 1·3207 | 1·3278 | 1·3349 | 1·3420 | 1·3491 | 1·3562 |
| 38 | 1·3634 | 1·3706 | 1·3778 | 1·3850 | 1·3923 | 1·3995 | 1·4068 | 1·4141 | 1·4214 | 1·4288 |
| 39 | 1·4361 | 1·4435 | 1·4509 | 1·4583 | 1·4657 | 1·4732 | 1·4806 | 1·4881 | 1·4956 | 1·5032 |
| 40 | 1·5107 | 1·5183 | 1·5258 | 1·5335 | 1·5411 | 1·5487 | 1·5564 | 1·5640 | 1 5717 | 1·5795 |
| 41 | 1·5872 | 1·5949 | 1·6027 | 1·6105 | 1·6183 | 1·6261 | 1·6340 | 1·6418 | 1·6497 | 1·6576 |
| 42 | 1·6656 | 1·6735 | 1·6815 | 1·6894 | 1·6974 | 1·7054 | 1·7135 | 1·7215 | 1·7296 | 1·7377 |
| 43 | 1·7458 | 1·7539 | 1·7621 | 1·7703 | 1·7784 | 1·7866 | 1·7949 | 1·8031 | 1·8114 | 1·8197 |
| 44 | 1·8280 | 1·8363 | 1·8446 | 1·8530 | 1·8613 | 1·8697 | 1·8781 | 1·8866 | 1·8950 | 1·9035 |
| 45 | 1·9120 | 1·9205 | 1·9290 | 1·9376 | 1·9461 | 1·9547 | 1·9633 | 1·9719 | 1·9806 | 1·9892 |
| 46 | 1·9979 | 2·0066 | 2·0153 | 2·0241 | 2·0328 | 2·0416 | 2·0504 | 2·0592 | 2·0680 | 2·0769 |
| 47 | 2·0857 | 2·0946 | 2·1035 | 2·1124 | 2·1214 | 2·1303 | 2·1393 | 2·1483 | 2·1573 | 2·1664 |
| 48 | 2·1754 | 2·1845 | 2·1936 | 2·2027 | 2·2118 | 2·2210 | 2·2301 | 2·2393 | 2·2485 | 2·2578 |

### No. 8.

## TABLE *of* DIFFERENCES *between*

| Inch. | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ·00037 | ·00045 | ·00054 | ·00063 | ·00074 | ·00084 | ·00096 | ·00109 | ·00122 | ·00136 |
| 2 | ·00151 | ·00166 | ·00183 | ·00199 | ·00217 | ·00236 | ·00255 | ·00275 | ·00296 | ·00317 |
| 3 | ·00339 | ·00362 | ·00386 | ·00411 | ·00436 | ·00462 | ·00489 | ·00517 | ·00545 | ·00574 |
| 4 | ·00604 | ·00634 | ·00666 | ·00698 | ·00731 | ·00764 | ·00799 | ·00834 | ·00870 | ·00906 |
| 5 | ·00944 | ·00982 | ·01021 | ·01060 | ·01101 | ·01142 | ·01184 | ·01227 | ·01270 | ·01314 |
| 6 | ·01359 | ·01405 | ·01451 | ·01499 | ·01547 | 01595 | ·01645 | ·01695 | ·01746 | ·01798 |
| 7 | ·01850 | ·01903 | ·01957 | ·02012 | ·02068 | ·02124 | ·02181 | ·02239 | ·02297 | ·02357 |
| 8 | ·02417 | ·02478 | ·02539 | ·02601 | ·02665 | ·02728 | ·02793 | ·02858 | ·02924 | ·02991 |

## No. 7.

## AREAS *of the* BUNG DIAMETERS *of* CASKS.

| Inch. | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | ·2719 | ·2765 | ·2811 | ·2857 | ·2904 | ·2951 | ·2998 | ·3046 | ·3094 | ·3142 |
| 13 | ·3191 | ·3241 | ·3290 | ·3340 | ·3391 | ·3442 | ·3493 | ·3544 | ·3596 | ·3649 |
| 14 | ·3701 | ·3754 | ·3808 | ·3862 | ·3916 | ·3970 | ·4025 | ·4081 | ·4136 | ·4192 |
| 15 | ·4249 | ·4306 | ·4363 | ·4421 | ·4478 | ·4537 | ·4596 | ·4655 | ·4714 | ·4774 |
| 16 | ·4834 | ·4895 | ·4956 | ·5017 | ·5079 | ·5141 | ·5204 | ·5267 | ·5330 | ·5393 |
| 17 | ·5457 | ·5522 | ·5587 | ·5652 | ·5717 | ·5783 | ·5849 | ·5916 | ·5983 | ·6051 |
| 18 | ·6118 | ·6187 | ·6255 | ·6324 | ·6393 | ·6463 | ·6533 | ·6603 | ·6674 | ·6745 |
| 19 | ·6817 | ·6889 | ·6961 | ·7034 | ·7107 | ·7181 | ·7254 | ·7329 | ·7403 | ·7478 |
| 20 | ·7554 | ·7629 | ·7705 | ·7782 | ·7859 | ·7936 | ·8014 | ·8092 | ·8170 | ·8249 |
| 21 | ·8328 | ·8407 | ·8487 | ·8567 | ·8648 | ·8729 | ·8810 | ·8892 | ·8974 | ·9057 |
| 22 | ·9140 | ·9223 | ·9307 | ·9391 | ·9475 | ·9560 | ·9645 | ·9731 | ·9817 | ·9903 |
| 23 | ·9990 | 1·0077 | 1·0164 | 1·0252 | 1·0340 | 1·0429 | 1·0518 | 1·0607 | 1·0697 | 1·0787 |
| 24 | 1·0877 | 1·0968 | 1·1059 | 1·1151 | 1·1243 | 1·1335 | 1·1428 | 1·1521 | 1·1614 | 1·1708 |
| 25 | 1·1802 | 1·1897 | 1·1992 | 1·2087 | 1·2183 | 1·2279 | 1·2376 | 1·2473 | 1·2570 | 1·2667 |
| 26 | 1·2765 | 1·2864 | 1·2963 | 1·3062 | 1·3161 | 1·3261 | 1·3361 | 1·3462 | 1·3563 | 1·3665 |
| 27 | 1·3766 | 1·3868 | 1·3971 | 1·4074 | 1·4177 | 1·4281 | 1·4385 | 1·4489 | 1·4594 | 1·4699 |
| 28 | 1·4805 | 1·4911 | 1·5017 | 1·5124 | 1·5231 | 1·5338 | 1·5446 | 1·5554 | 1·5663 | 1·5772 |
| 29 | 1·5881 | 1·5991 | 1·6101 | 1·6212 | 1·6322 | 1·6434 | 1·6545 | 1·6657 | 1·6770 | 1·6882 |
| 30 | 1·6995 | 1·7109 | 1·7223 | 1·7337 | 1·7452 | 1·7567 | 1·7682 | 1·7798 | 1·7914 | 1·8030 |
| 31 | 1·8147 | 1·8265 | 1·8382 | 1·8500 | 1·8619 | 1·8737 | 1·8857 | 1·8976 | 1·9096 | 1·9216 |
| 32 | 1·9337 | 1·9458 | 1·9579 | 1·9701 | 1·9823 | 1·9946 | 2·0069 | 2·0192 | 2·0316 | 2·0440 |
| 33 | 2·0564 | 2·0689 | 2·0814 | 2·0940 | 2·1066 | 2·1192 | 2·1319 | 2·1446 | 2·1574 | 2·1701 |
| 34 | 2·1830 | 2·1958 | 2 2087 | 2·2217 | 2·2346 | 2·2476 | 2·2607 | 2·2738 | 2·2869 | 2·3001 |
| 35 | 2·3133 | 2·3265 | 2·3398 | 2·3531 | 2·3664 | 2·3798 | 2·3933 | 2·4067 | 2·4202 | 2·4338 |
| 36 | 2·4473 | 2·4610 | 2·4746 | 2·4883 | 2·5020 | 2·5158 | 2·5296 | 2·5434 | 2·5573 | 2·5712 |
| 37 | 2·5852 | 2·5992 | 2·6132 | 2·6273 | 2·6414 | 2·6555 | 2·6697 | 2·6839 | 2·6982 | 2·7125 |
| 38 | 2·7268 | 2·7412 | 2·7556 | 2·7700 | 2·7845 | 2·7991 | 2·8136 | 2·8282 | 2·8428 | 2·8575 |
| 39 | 2·8722 | 2·8870 | 2·9018 | 2·9166 | 2·9314 | 2·9463 | 2·9613 | 2·9763 | 2·9913 | 3·0063 |
| 40 | 3·0214 | 3·0365 | 3·0517 | 3·0669 | 3·0821 | 3·0974 | 3·1127 | 3·1281 | 3·1435 | 3·1589 |
| 41 | 3·1744 | 3·1899 | 3·2054 | 3·2210 | 3·2366 | 3·2523 | 3·2680 | 3·2837 | 3·2995 | 3·3153 |
| 42 | 3·3311 | 3·3470 | 3·3629 | 3·3789 | 3·3949 | 3·4109 | 3·4270 | 3·4431 | 3·4592 | 3·4754 |
| 43 | 3·4916 | 3·5079 | 3·5242 | 3·5405 | 3·5569 | 3·5733 | 3·5897 | 3·6062 | 3·6227 | 3·6393 |
| 44 | 3·6559 | 3·6725 | 3·6892 | 3·7059 | 3·7227 | 3·7395 | 3·7563 | 3·7732 | 3·7901 | 3·8070 |
| 45 | 3·8240 | 3·8410 | 3·8580 | 3·8751 | 3·8923 | 3·9094 | 3·9266 | 3·9439 | 3·9611 | 3·9785 |
| 46 | 3·9958 | 4·0132 | 4·0306 | 4·0481 | 4·0656 | 4·0832 | 4·1007 | 4·1183 | 4·1360 | 4·1537 |
| 47 | 4·1714 | 4·1892 | 4·2070 | 4·2249 | 4·2427 | 4·2607 | 4·2786 | 4·2966 | 4·3146 | 4·3327 |
| 48 | 4·3508 | 4·3690 | 4·3872 | 4·4054 | 4·4236 | 4·4419 | 4·4603 | 4·4787 | 4·4971 | 4·5155 |
| 49 | 4·5340 | 4·5525 | 4·5711 | 4·5897 | 4·6083 | 4·6270 | 4·6457 | 4·6645 | 4·6833 | 4·7021 |
| 50 | 4·7210 | 4·7399 | 4·7588 | 4·7778 | 4·7968 | 4·8158 | 4·8349 | 4·8541 | 4·8732 | 4·8924 |

## No. 8. (*Continued.*)

## *the* HEAD *and* BUNG DIAMETERS.

| Inch. | ·0 | ·1 | ·2 | ·3 | ·4 | ·5 | ·6 | ·7 | ·8 | ·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | ·03059 | ·03127 | ·03196 | ·03266 | ·03337 | ·03408 | ·03480 | ·03553 | ·03627 | ·03701 |
| 10 | ·03777 | ·03852 | ·03929 | ·04007 | ·04085 | ·04164 | ·04243 | ·04324 | ·04405 | ·04487 |
| 11 | ·04570 | ·04653 | ·04737 | ·04822 | ·04908 | ·05004 | ·05082 | ·05170 | ·05259 | ·05348 |
| 12 | ·05438 | ·05529 | ·05621 | ·05714 | ·05807 | ·05901 | ·05996 | 06091 | ·06188 | ·06285 |
| 13 | ·06383 | ·06481 | ·06581 | ·06681 | ·06781 | ·06883 | ·06985 | ·07089 | ·07192 | ·07297 |
| 14 | ·07393 | ·07509 | ·07615 | ·07723 | ·07831 | ·07941 | ·08051 | ·08161 | ·08273 | ·08385 |
| 15 | ·08498 | ·08611 | ·08726 | ·08841 | ·08957 | ·09074 | ·09191 | ·09309 | ·09428 | ·09548 |

No. 9.—TABLES *shewing the usual* FORMS *and* DIMENSIONS *of* CASKS *imported into, and used in the* UNITED KINGDOM.

| Name and Description of Casks. | Usual Average Dimensions. | | | | | Usual allowance to reduce to a spheroid. |
|---|---|---|---|---|---|---|
| | Length. | Head. | Bung. | Content. | Thickness of Staves. | |
| WINE. | | | | | | |
| *Cape Pipes*—stout made, various - | 47·8 | 22·8 | 28·5 | 96 | 1·0 | ·5 to 1·0 |
| — *Hogsheads*—stout made - - | 31·5 | 19·4 | 23·6 | 44 | 1·0 | ·2 to ·4 |
| *Claret, and Burgundy Hhds*—various | 28·5 | 22·5 | 25·0 | 47 | 1·0 to 1.2 | ·0 ·0 |
| *Fayal Pipes*—various - - - | 47·5 | 21·7 | 27·7 | 89 | various | ·4 to ·8 |
| *Lisbon Pipes*—bad fig. h b. hollow q. | 47·5 | 24·8 | 32·7 | 123 | 1·0 | 1·0 to 1·5 |
| — *Hogsheads*—thin, well made - | 29·0 | 25·0 | 28·0 | 60 | ·75 | ad·3 to ·5 |
| *Madeira Pipes*—rough irr, stout, ill m. | 47·5 | 21·4 | 28·5 | 93 | various | 1·0 to 2·0 |
| — *Hogsheads*—stout, ill made - - | 32·5 | 19·0 | 23·5 | 44 | 1·0 | ·3 to ·5 |
| *Mountain Butts*—well made - - | 41·0 | 26·6 | 32·0 | 106 | 1·0 | ·4 to ·6 |
| *Port Pipes*—stout, well made - - | 50·2 | 22·7 | 31·5 | 118 | 1·0 | ·3 to ·6 |
| — *Hogsheads*—thin, well made - | 32·0 | 22·8 | 27·0 | 59 | ·75 | ·0 ·0 |
| *Rhenish Vats*—good fig. dished heads | 56·0 | 36·0 | 42·0 | 255 | various | 1·8 to 3·0 |
| — *Four Aums*—smooth, well made - | 41·0 | 28.0 | 34·8 | 124 | 1·0 | ·6 to ·8 |
| — *Double Aums*—smooth, good figures | 31·5 | 23·7 | 27·5 | 61 | 1·0 | ·2 to ·4 |
| *Sherry Butts*—thin, good figures - | 42·5 | 26·5 | 32·5 | 113 | 1·0 | ·2 to ·5 |
| — *Hogsheads*—thin, well formed - | 30·5 | 23·0 | 26·5 | 55 | ·75 | ·0 ·0 |
| *Sicilian Pipes*—stout made, various - | 46·4 | 22·4 | 28·6 | 93 | 1·0 | ·6 to 1·0 |
| — *Hogsheads*—stout ill made - - | 35·6 | 17·0 | 23·1 | 45 | 1·0 | ·4 to ·6 |
| *Spanish Red Pipes*—cylindrical - - | 47·2 | 25·6 | 28·8 | 103 | 1·0 | ·4 to ·7 |
| *Ditto*—conical cocked bung - - | 50·0 | 22·8 | 31·3 | 116 | various | 1·0 to |
| —*Hogsheads*—cylindrical rough made | 30·0 | 21·0 | 24·0 | 45 | 1·0 | ·2 to |
| *Teneriffe Pipes*—thin, bad fig. hol. q. | 47·4 | 23·3 | 28·8 | 98 | 1·0 | ·5 to |
| — *Hogsheads*—long, thin made - - | 32·0 | 19·0 | 24·5 | 47 | ·75 | ·2 to |
| BRANDY. | | | | | | |
| *Bourdeaux Puncheons*—rough, ordin. | 46·8 | 26·0 | 30·5 | 112 | 1·0 | ·4 to |
| — *Hogsheads*—thick rough insides - | 37·5 | 25·5 | 28 5 | 80 | 1·0 | ·3 to |
| *Charante Puncheon*—thin, good figure | 46·0 | 26·5 | 31·0 | 114 | various | ·0 to ·4 |
| *Naples Pipes*—bad figure rough insid. | 46·0 | 26·5 | 31·5 | 116 | 1·0 | ·8 to 1· |
| *Spanish Butts*—thick rough cylindric. | 43·0 | 38·0 | 42·0 | 202 | 1 0 | ·7 to 1·0 |
| — *Pipes*—ordinary - - - - | 46·0 | 25·8 | 28·8 | 101 | 1·0 | ·4 to ·7 |
| GENEVA. | | | | | | |
| *Puncheons*—various - - - | 44·6 | 25·0 | 29·4 | 99 | 1·0 | ·3 to ·5 |
| *Hogsheads*—various - - - | 33·0 | 19·5 | 25·5 | 52 | various | ·0 ·04 |
| RUM. | | | | | | |
| *English Puncheon*—good figure - } | 34·5 | 27·6 | 32·3 | 92 | 1·0 | ·2 to ·4 |
| *West India Puncheon*—bad figure } | | | | | various | ·3 to ·6 |
| *Hogsheads*—long, thin, bad figure } | 31·0 | 22·0 | 26·0 | 53 | ·75 | ·2 to ·4 |
| *Porter Casks*—stout good figure } | | | | | 1·0 | ·2 to ·4 |
| OLIVE OIL. | | | | | | |
| *Gallipoli Butts*—short, ordinary - | 44·6 | 36·5 | 41·4 | 201 | 1·0 | 1 0 to 1·2 |
| — *Large Pipes*—stout, ordinary - | 48·6 | 28·4 | 33·4 | 139 | 1·0 | 1 0 |
| — *Small Pipe*—thin, ordinary - | 46·6 | 25·6 | 29·6 | 106 | 1·0 | ·6 to ·8 |
| — *Short Puncheons*—thin, bad figure | 35·6 | 29.2 | 32·6 | 100 | 1·0 | ·5 |
| — *Short Casks*—hin, bad figure - | 29·6 | 24.6 | 28·6 | 62 | 1·0 | 0 ·0 |
| *Genoa Butts*—stout, ordinary figure - | 46·8 | 28·6 | 32·5 | 130 | 1·0 | 1 0 |
| — *Pipes*—stout, well made - - | 44·6 | 26.5 | 29·5 | 102 | 1·0 | ·6 to ·8 |
| WHALE OIL. | | | | | | |
| *Large Butts*—stout, well made - | 58·5 | 40·6 | 46·6 | 332 | 1·0 | 2·5 |
| — *Small Butts*— do. - - | 54·0 | 34·0 | 40·0 | 222 | 1·0 | 2·0 to 2·2 |
| — *Long Pipes*—stout, well made - | 54·0 | 24·4 | 29·4 | 118 | 1·0 | 1·5 to 1·6 |
| — *Long Breakers*—stout, well made | 54·0 | 20·4 | 24·6 | 82 | 1·0 | 1·5 to 1·8 |

# EXCISE ESTABLISHMENT.—COMMISSI

## Commiss

JOHN WOOD, I

HART DAVIS, Esq., *Deputy Chairman.*
SIR J. CHEETHAM MORTLOCK, *Knt.*

The Hon. BERKE
Hon. Capt. WILLI

## Heads of Depa

*Secretary*—J. Clayton Freeling, Esq.
*Under Secretary*—C. Browne, Esq.
*Assistant Secretary*—G. Ballard, Esq.
*Correspondent*—John Brown, Esq.
*First Assistant*—Mr Jer. Ottley.
*Correspondent for Scotland and Ireland*—John Norman, Esq.
*First Assistant for Scotland*—Mr. William Anderson.
*First Assistant for Ireland*—Mr. M. Stritch.
*Solicitor*—Wm. K. Dehany, Esq.
*Assistant Solicitor*—P. W. Mayow, Esq.
*Solicitor for Scotland*—M. Carr, Esq.
*Solicitor for Ireland*—M. A. Saurin, Esq.
*Registrar*—Mr. W. Riddle.
*Comptroller General*—J. Rotton, Esq.
*Auditor*—R. V. Davis, Esq.
*Deputy*—Mr. O. Naylor.
*Stamp Distributor*—J. Dennis, Esq.

## General Accou

*Accountant General*—A. Cotterell, Esq.
*Assistant*—Mr. L. S. Lyne.
*Consolidated Duties*—Robert Cooper, Esq.
*General Accountant for Scotland*—John H. Wingrave, Esq.
*General Accountant for Ireland*—Joseph Atwell, Esq.

## Surveying Genera

FIRST CLASS.—Thomas Bett, William Baker, Daniel Willi

SECOND CLASS.—John Voyce, Thomas Walton, Jonathan Barber, Thomas Salmon, William Goodall, Henry Smith, Gold

THIRD CLASS.—Joseph Spivey, Benjamin Par

FOURTH CLASS.—William Hawkins, Donald Ross, George Clements, Franci Godsall, Joshua Shacklock, William Humphreys, Edgar E

## Collect

*Barnstable*—Thos. Williamson, Esq.
*Bath*—John Savory, Esq.
*Bedford*—John Manners, Esq.
*Bristol*—Francis Amey, Esq.
*Cambridge*—John Thompson, Esq.
*Canterbury*—Francis Brothers, Esq.
*Chester*—James Bassett, Esq.
*Cornwall*—Edward Hillborne, Esq.
*Coventry*—John Tanfield, Esq.
*Cumberland*—George Robinson, Esq.
*Derby*—John Etherington, Esq.
*Dorset*—William Wallace, Esq.
*Durham*—James Baxter, Esq.
*Essex*—John Badcock, Esq.
*Exeter*—John Herdson, Esq.
*Gloucester*—Thomas Wright, Esq.
*Grantham*—John Nutting, Esq.
*Halifax*—
*Hants*—W. Wright, Esq.
*Hereford*—Samuel Crowther, Esq.
*Hertford*—Charles Bassett, Esq.
*Hull*—George Wood, Esq.
*Isle of Wight*—J. Baker, Esq.
*Lancaster*—John Kay, Esq.
*Leeds*—Jesse Woodward, Esq.
*Lichfield*—Charles Instan, Esq.
*Lincoln*—T. Rayner, Esq.
*Liverpool*—Holliday Flewker, Esq.

*Aberdeen*—James M'Laren, Esq.
*Ayr*—John Wharton, Esq.
*Argyle North*—Wm. Torrance, Esq.
*Argyle South*—Geo. Sutherland, Esq.
*Caithness*—S. C. Pearce, Esq.
*Dumfries*—Thomas Dean, Esq.
*Edinburgh*—James Cornwall, Esq.
*Elgin*—William Marks, Esq.

*Armagh*—Beauchamp Hill, Esq.
*Athlone*—
*Coleraine*—William Garerd, Esq.
*Cork*—John Clark, Esq.
*Clonmel*—William Miller, Esq.
*Drogheda*—Thomas Gill, Esq.
*Dublin*—George Pape, Esq.
*Dundalk*—William Kilpatrick, Esq.
*Foxford*—R. Manning, Esq.
*Galway*—Norman Ash, Esq.
*Wexford*—John B

## General Su

James Gaisford, J. B. Scott, William Perrin, J. Phillips, Josh

# ONERS AND PRINCIPAL OFFICERS.

## ioners.

Esq., *Chairman.*

LEY PAGET. THOMAS HARRISON, Esq.

AM HENRY PERCY. HENRY F. STEPHENSON, Esq.

## rtments, &c.

*Receiver General*—J. Backhouse, Esq.
*Clerk of Securities*—W. F. Thornton, Esq.
*Assistant*—W. E. Gowland, Esq.
*Clerk of the Diaries*—Mr. William Davy.
*Clerk of the Diaries for Scotland and Ireland*—Mr. Thomas Tucker.
*Permit Examiner*—Mr. L. Dunbar.
*Inspector of Permit Paper*—Mr. Wm. Mayhew.
*Chief Inspector of Revenue Police*—Lieut.-Col. J. Brereton, R.A.
*Port Surveyors*—Thomas Bennett, and J. Bolton, Esquires.
*Export Surveyors*—John Ley and R. Betts, Esquires.
*Storekeeper*—Wm. Johnson, Esq.
*Surveyor of Buildings*—Wm. Herbert, Esq.
*Warehouse-keeper*—Mr. Saunders.
*First Door-keeper*—Mr. J. Erford.

## ntants, &c.

*London Duties and Debentures*—G. Gillio, Esq.
*Auctions*—John Cooper, Esq.
*Fines &c.*—John Gowland, Esq.
*Bills and Licences*—Geo. Keele, Esq.
*Acct. for Distribution.*—Mr. Rich. Dawson.

## il Examiners.

am Logie, James Steel, and Thomas Julians, Esquires.

Rayner, Richard Dixon, James Williamson, James Napper, James ing Bird, and John Stothard, Esquires.

ker, and William Blackburn, Esquires.

s Ayrton, Robert Elwin, Samuel C. Brown, Thomas Weston, Edward ldred, Luke Kingsmill, and Joseph Longrigg, Esquires.

## tors.

*Lynn*—John Rucastle, Esq.
*Manchester*—John Ryan, Esq.
*Newcastle*—R. S. Stanley, Esq.
*Northampton*—John Knapton, Esq.
*Northwich*—Thomas Ryder, Esq.
*Norwich*—George Lowes, Esq.
*Oxford*—John Smith, Esq.
*Plymouth*—G. Gidley, Esq.
*Reading*—T. P. Orum, Esq.
*Rochester*—John Sykes, Esq.
*Salisbury*—William Adams, Esq.
*Salop*—William Wardley, Esq.
*Sheffield*—J. Thompson, Esq.
*Stafford*—Job Douglas, Esq.
*Stourbridge*—Richard Yeomans, Esq.
*Suffolk*—J. Cardew, Esq.
*Surrey*—
*Sussex*—Richard Hill, Esq.
*Uxbridge*—William Allen, Esq.
*Wales East*—John Lewis, Esq.
*Wales Middle*—Robert Buckle, Esq.
*Wales North*—John Mayhew, Esq.
*Wales West*—Thomas Barfield, Eqs.
*Wellington*—Joseph Cartner, Esq.
*Whitby*—J. Bridgwater, Esq.
*Wigan*—Joseph Shaw, Esq.
*Worcester*—Wm. Newby Plant. Esq.
*York*—Evan Evans, Esq.

---

*Fife*—James Troup. Esq.
*Glasgow*—James Dumbreck, Esq.
*Haddington*—Jas. Thompson, Esq.
*Inverness*—Alexander Cormick, Esq.
*Linlithgow*—Alex. Williamson, Esq.
*Montrose*—John Corbet, Esq.
*Perth*—John Anderson, Esq.
*Stirling*—Alex. Halliburton, Esq.

---

*Kilkenny*—John Wemyss, Esq.
*Limerick*—Thomas O'Flaherty, Esq
*Lisburn*—Robert Smith Sharp, Esq.
*Londonderry*—Wm. Middleton, Esq.
*Maryborough*—J Johnstone, Esq.
rown, Esquire.
*Mallow*—Patrick Kelly, Esq.
*Naas*—Samuel Morewood, Esq.
*Sligo*—John Chambers, Esq.
*Tralee*—Benjamin Mathews, Esq.
*Waterford*—John Corbett, Esq.

## rveyors.

ua Bartlett, William Ouston, and S. Clark, Esquires.

THE

# EXCISE OFFICER'S MANUAL.

---

## BOOK II.

CONTAINING AN ACCOUNT OF THE EXCISE ESTABLISHMENT AND OF THE DUTIES UNDER THE MANAGEMENT OF THE EXCISE COMMISSIONERS.

---

## CHAPTER. I.

## THE EXCISE ESTABISHMENT.

THE EXCISE (from the Belg. *Acciise* Tributum*) is a duty or imposition on home made goods or commodities, as distinguished from *Customs*, which is a duty on goods imported from another country. The Establishment for collecting and managing the Excise duties, consists of a board of Commissioners and a great number of officers acting under them.

### PART I.—OF THE BOARD OF COMMISSIONERS.

THE Board of Excise consists of seven commissioners who sit and act officially at the Excise Office, Old Broad-street, London. Formerly the number of Commissioners was greater, and there was a separate board for Scotland, and another for Ireland; but the powers of the present commissioners extend to the whole of the United Kingdom.

By the 7 and 8 Geo. IV, c. 53, as well as by patent, the commissioners are entrusted with the collection and management of the whole revenue of excise of the United Kingdom of Great Britain and Ireland; subject however, in all things relating to the execution of their duty, to the control of the Lords Commissioners of Her

---

* Jacob's Law Dictionary.

Majesty's Treasury. The commissioners of Excise are authorized and required, from time to time, to appoint such collectors, subordinate officers, accountants, clerks, and assistants, as to them shall seem requisite; and to allow and pay for charges necessarily arising in the collection or management of the excise; such allowances being conformable to any rules or directions received from the Treasury;—provided that the number of each description of officers and persons so to be appointed, shall not in any case exceed the number fixed by general warrant or order from the Treasury.

The Commissioners are also required to collect all and every part of the revenue of Excise, and to keep separate and distinct accounts thereof, respectively at the chief office of Excise in London. They are to set forth the amounts collected, and remaining in arrear; and of the several payments made or allowed, and of the expences made or incurred: and they are to render and furnish to the Lords of the Treasury such accounts when and so often as the same shall be directed or required.

The Salaries of the Commissioners are as follows: Chairman, £2,000.; Deputy Chairman, £1500. ; the other Commissioners, £1200. each.

## PART II.—THE SURVEYING DEPARTMENT.

The most important branch of the Excise establishment, is the *surveying department*, consisting of a body of officers of different ranks and classes, but all of them either in, or having been raised from, the lowest class; it being the distinguishing feature of this department that no person is eligible for a higher station, unless and until he has passed through the subordinate ones.

The mode in which the different officers of this department are appointed, and the general nature of the duties of each class, are as follows:

### 1. *Of the Officers' Appointment; or, Order for Instructions.*

The first appointment of a person intended for the surveying department of the excise, is called an "Order for instructions." These orders are given on the nomination either of the Lords of the Treasury or of the commissioners of excise, the patronage being divided between them. The commissioners set apart a number of appointments for the sons of officers with very large families, &c.; and the rest are disposed of by the individual commissioners.

A certain number of these appointments are made annually, with a view to the supply of any vacancies which may occur in the establishment.

The age at which a person is admissible to an order for instructions is from nineteen to thirty. It is required that if he be married he should not have more than two children; that he should be healthy, active, and free from debt, and that he should possess a good knowledge of vulgar and decimal arithmetic. Having obtained the order for instructions, the pupil is placed under the tuition of some officer to be approved of by the proper supervisor; and the instructions continue during a period which must not be less than six weeks, and as much longer as is necessary to enable the supervisor who examines the qualifications of the person appointed, to certify that he is fitted to survey the different traders under the excise. The supervisor, before he certifies that any person is fully instructed, is to be well satisfied that he can cast up both excise and malt gauges by the pen and sliding rule; and that such person has gauged and stocked for a Month in the station in which he was instructed, and entered the same in a book provided by him for that purpose; and that he has made true vouchers and an abstract therefrom; and that he is in all respects well qualified for a gauger's employment; and without any apparent bodily infirmity. The supervisor's fee for examination and certificate is20s. ; and the officer for giving the instructions usually receives two Guineas.

During the time of receiving instructions no renumeration is paid to the person appointed; but as soon as the proper certificates are received at the chief office, he is appointed an Expectant; until which time he is not considered to be in the board's employment.

### 2—*Of Expectants.*

An Expectant is an officer who is employed in doing duty for sick and absent officers. Before commencing his employment he has to enter into a bond with two securities for the proper performance of his duties, and also to obtain a certificate of having made the following declaration before a Magistrate, or a Baron of the Exchequer.

"I. A B. do sincerely and solemnly declare, that I will bear true "allegience to Her Majesty, and will execute the office of*

---

* A similar declaration is made by every person appointed in the Excise; 7 & 8 Geo. 4, c. 53 s. 7.

" to which I am appointed, truly and faithfully, without favour or " affection; and that I will from time to time true account make and "deliver to such person or persons as shall be duly appointed to " receive the same; and that I will not take any fee or reward in or " for the execution of the said office from any other person than her " Majesty or those whom her Majesty shall appoint in that behalf."

An expectant has a fixed salary of £50 per annum, and when employed he receives an additional allowance at the rate of £30 per annum. As vacancies happen the Expectants are appointed Supernumeraries or Assistants.

### 3. *Of Assistants and Supernumeraries.*

An Assistant is an officer whose duty is to watch the operations of a single trader, as a soap maker or other trader where the constant presence of an officer is necessary; he is also employed to relieve the established officers at those seasons of the year, at which the operations of the manufacturers are carried on with the greatest activity. The salary is £85 per annum. A Supernumerary attends the collector on the rounds, which are made eight times a year. He carries the official papers and documents, and is required to provide himself with a horse. His salary is £52 per annum, and when officiating for an officer he receives an additional payment, at the rate of £38 per annum. An Assistant or a Supernumerary is eligible to the situation of surveying officer after four months' employment, and may be appointed on petition, or as vacancies occur.

### 4. *Of Surveying Officers.*

An Officer is employed to survey the Excise Manufacturers and traders within either a *ride* or *foot walk*; the former comprising an extent of country in which traders are thinly scattered, and for which the officer is required to keep a horse; but in foot walks the business is generally much more concentrated, and is usually confined to towns and places where the traders, either from the nature or extent of their operations, or both combined, require more attention and more frequent surveys.

The duty of a surveying officer is to attend the traders in his business, under the prescribed rules laid down in his instructions, for checking and taking account of the different operations which such traders are carrying on; and when notice is required of a trader's intention to commence an operation, the officer has to attend at the time fixed in such notice, or as near thereto as possible in order that the required account may be taken. He, on all such occasions records in his books the day and hour of his survey, and the condition of the entered utensils, &c., and the progress of the different operations carrying on. In some branches of manufacture the charging of the duty is a process which occupies much of the officer's time, and requires the utmost dexterity and exactness. In addition to these duties, the officer is required to survey and take account of the stocks of all dealers in exciseable articles residing within the range of his particular duty. It will thus be obvious how greatly the security of the revenue depends on a vigilant survey of the different Traders; and that in point of fact the business of an Excise officer, to perform it efficiently, is one of constant inspection and unremitting watchfulness. In certain cases he is required to survey in the night as well as in the day. The average time an officer is actually on duty is estimated at twelve or thirteen hours a day; and the number of miles performed daily by a ride officer is seldom less than eighteen, on an average. Before going out on each day's survey, if his duty is not what is called "in residence," the officer is required to leave a memorandum behind him, specifying the different places he is about to visit in the course of the day, and the order in which he will visit them. On all occasions he is subject to a most rigorous system of inspection by his supervisor and other superior officers; the supervisor being obliged to enter in his diary every error he discovers. After an officer has been four years in one situation, he is liable to be removed to another. The salary of ride and foot walk officers, is £100, out of which the former must find and keep a horse.

Every officer is enjoined by his instructions to carry his commission with him when on survey, and readily to shew it to such persons concerned as may demand to see it. He is also, by a civil and becoming behaviour, to avoid giving any just occasion of complaint to any person with whom he is concerned by virtue of his office.* He is strictly prohibited from keeping double books, or altering figures; and also from receiving any rewards or treats from the traders under his survey: and collusion or bribery of any kind, subjects him to discharge and very heavy punishment. 7 and 8 Geo. IV. c. 53.

Ride officers who have been three years employed, two of which have been in a ride, are eligible for promotion to a division or foot walk; and after a service of nine years (three of which must have been passed in the latter station,) an officer is eligible for the situation of Examiner.*

---

* So long as an officer thus conducts himself to the traders under his survey, he is entitled to the same respect from them.

The following situations, are filled up by selection from the Surveying branch, *i. e.* from Surveying officers or Supervisors, viz.—*Correspondent's department*, 8th assistant, (£140) rising in progression to the 3rd assistant, (£200) *Correspondent's department, Scotch Branch*, 2nd assistant, (£250,) 3rd do. (£200,) 4th do. (£150,) 5th do. (£100.) *Correspondent's department, Irish Branch*, 2d assistant, (£250,) 3rd do.. (£200,) 4th do (£200,) 5th do. (£160,) 6th do. (£140,) 7th do. (£130,) 8th do. (£120,) 9th do. (£110,) 10th do. (£100.) *Permit Department*,—Inspector of Permit Paper, (£158 15 0.) Chief Permit Examiner (£150,) Permit Examiner (£100) each, 7 do. (£90) each. *Diary office*, Clerk of the diaries, (£170,) 1st assistant (£150,) 2nd and 3rd do. (£140) each. Clerk of the diaries for Scotland and Ireland, (£170.) Also collectors, clerks with salaries of from £100 to £150.†

### 5. *Of Examiners.*

Examiners are promoted from division officers, and are appointed in turn to the station of supervisors as vacancies arise. Their duties at the Head Office chiefly consist in examining the survey books of officers, with a view to their promotion, or otherwise; and also the table and dimension books containing the dimensions of the several entered vessels and utensils, &c., used by Excise traders, and the calculations of their areas and capacities. They are also employed in the country, officiating for supervisors who may be incapable of business through indisposition or other causes. The salary of a Country Examiner, is £150 per annum, and when employed as Supervisor he receives an additional allowance at the rate of £50 per annum.

---

* Although Officers are thus eligible for advancement to the higher grades, they ought never to forget that their promotion is dependent upon their own conduct and character; (*vide infra p.*266) and, in order to qualify themselves for such higher stations, they should be careful not to neglect any means of improvement within their reach. The *Young Officer*, in particular, ought carefully to attend to the character of his hand-writing, which cannot be too plain and distinct;—to his mode of diction and expression, which is constantly brought, in one shape or other, under the notice of his superior officers, not excepting the Commissioners themselves;—to the correctness of his computations and book-keeping, upon which depend, not only the security of the revenue, but in a great measure also, his own success as an officer;—and, above all, to the cultivation of a strictly moral character; devoting his energies to the conscientous discharge of his onerous duties, and the good of the community. Formerly instances have occurred of persons rising to the higher stations in the excise with only moderate abilities; but the Commissioners have come to the determination of selecting, for the future, only those officers whose character, talents and aquirements will do honor to the stations they are designed to fill.

† Most of these particulars are taken from the Commissioners report on the Excise enquiry, but it is understood that the practice in respect to promotion is not uniform, and that there has subsequently been some alteration in the stations and salaries.—*See also p.* 253.

### 6. *Of Supervisors.*

A Supervisor has charge of a district comprising a certain number of stations called respectively rides and foot walks. His principal duty is to survey the traders and check the performances of the officers in his district, by frequent visits on them, and at uncertain times; and also to examine the survey books and accounts. The Supervisor has also to correspond with the Board upon all matters connected with the business of his district; and he is required to keep a diary in which to record the particulars of how he has been employed every day, and of the errors he may have discovered in the conduct and performances of the officers under his superintendence. The salary of this station is £200 per annum, out of which supervisors in wide or riding districts have to provide and keep a horse. Upon the exertions and vigilance of the supervisor the security of the revenue very materially depends; and his duties are incessant and in the highest degree laborious. It has been calculated that supervisors are occupied on an average, not less than fifteen hours a day, and that in riding districts they have to travel not less than twenty three miles a day. A supervisor who has been employed five years in that station, is eligible for the appointment of Collector: he is also eligible to be appointed a Surveying General Examiner after three year's employment.

The following situations are likewise filled up either from supervisors, or Surveying General Examiners:—*Correspondents department*, Correspondent (£500,) 1st Assistant, (£300,) 2nd do. (£250,) Correspondent for Scotland and Ireland, (£500,) 1st Assistant, Scotch branch (£350,) 1st Assistant, Irish branch, (£350.) *

### 7. *Of Collectors.*

A collection consists of several districts; and the business of the Collector is to visit and hold a sitting for the collection of the Excise duties in every market town in his collection, at stated intervals, eight times in the year. The proper supervisors and officers attend him; and at their Meetings he inspects and examines the supervisors diaries, hears the officers' explanations of the complaints stated against them, and writes his observations on the same for the several parties to sign. In the intervals between holding the roundly sittings as above described, the Collector is employed in attending to prosecutions for penalties and duties before the Magistrates; in making out and transmitting his voluminous accounts and returns; and in the investigation of all questions of importance which arise within the circuit of his collection. Various additional duties are imposed upon the Collector, which are not in any way connected with the revenue, such as the payment of Navy allotments; the out-pensioners of Chelsea Hospital, half-pay, and widows' pensions, revenue prisoners' allowances, and many other services of a similar nature. The salaries of Collectors vary from £350 to £600 per annum.

---

* See also page 252. Several appointments in the *Secretary's* office were formerly made also from the Surveying Department.

### 8. *Of Surveying General Examiners.*

The Surveying General Examiners report upon all questions of intricacy and doubt which may involve either the rates of duty, or the regulations affecting the charge, or the process of manufacture of exciseable articles. They revise the schemes proposed for the distribution of business throughout the country; and they consider and report upon all proposals for the amendment of the laws. A number of them is continually employed on survey in the country, checking the operations of the traders, and the mode in which the officers perform their several duties.

The Surveying General Examiners are divided into 4 classes, the appointments from the station of supervisor being always to the fourth class, from which they are afterwards promoted upon vacancies to the higher classes. The number and salaries of each class are as follows:—

| | | | £ | | | | £ |
|---|---|---|---|---|---|---|---|
| 5 First Class:— | 1 | at | 550 | 5 Third Class:— | 1 | at | 350 |
| | 3 | at | *500 | and | 4 | at | 300 |
| and | 1 | at | 450 | 20 Fourth Class:— | 6 | at | 300 |
| 17 2nd Class:— | 1 | at | 400 | and | 14 | at | 250 |
| and | 16 | at | 350 | | | | |

---

* On the appointment to the next vacancy in the First Class at the £500 rate of Salary it will be made at £450, thereby leaving one at £550, two at £500, and two at £450 per annum.

### 9. *Of the Country Establishment.*

For the purpose of collecting the duties, and performing the extensive business connected with the inland revenue, the whole of the United Kingdom is partitioned into convenient portions, in each of which is organized a certain number of officers of various ranks, corresponding with the duties allotted to them. England and Wales are divided into 56 great parts, which are known under the name of collections. Scotland is divided into 16 collections, and Ireland into 21. The name of a County, a large portion of which is comprized within their limits, is given to some collections, and others are known by the name of some great Town which they contain. Each collection is divided into districts, usually into six or seven, though there are some collections which contain only four. The total number of districts in England and Wales, is 320, in Scotland 84, and in Ireland 78. Each district is again subdivided into rides and foot walks, or divisions; the former including a portion of country never exceeding twenty miles; and the latter comprehending a greater circuit. The chief officer of each collection, is the Collector who is allowed a clerk; and in two or three collections, more than one clerk is required. Each district is in charge of a Supervisor, and over each division or ride, is a surveying officer. There is likewise a supernumerary officer in each collection, and in many of them are also assistants and expectants.

The following scheme or table of the distribution of the business in the country establishment will be best appreciated by those for whom it has been compiled. It is not put forward as a perfect document, and every year will render it less correct, in consequence of the great changes which are continually taking place; but it will always be found more or less useful as a matter of reference. It shows the name of each collection and district, the county in which the district residence is situate, and its distance from London. It also contains, as nearly as could be ascertained, the number of divisions and rides in each district, and the miles including and excluding cautionary traders respectively; with the distance of each officer from the supervisor's residence.*

---

* The notes also contain the name of each collection, and of the collector's residence, and also the principal towns through which the collectors pass on their rounds; and the figures at the end denote:—S. the Collector's Salary; C. the Clerk's Salary; D. the net duties collected in the year 1839; and M. the miles travelled on the rounds.

## ENGLAND.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BARNSTAPLE.* | | | | | | | | | | | |
| Barnstaple, *Dev.* 195 - | 4 | 5 | 298 | 159 | 1 | 6 | 11 | 12 | | | |
| Bideford, *Dev.* 204 - | 4 | 5 | 291 | 190 | 3 | 6 | 7 | 7 | 13 | 21 | 25 |
| Dunster, *Som.* 158 - | 1 | 7 | 311 | 284 | 2 | 3 | 7 | 8 | 8 | 10 | 17 |
| Launceston, *Corn.* 213 - | 1 | 7 | 440 | 366 | 2 | 5 | 6 | 12 | 14 | 17 | 18 |
| South Molton, *Dev.* 181 - | 1 | 7 | 372 | 198 | 3 | 3 | 9 | 11 | 18 | 26 | |
| BATH.† | | | | | | | | | | | |
| Bath, 1st *Som.* 106 - | 4 | 3 | 152 | 145 | 2 | 11 | 12 | | | | |
| Ditto. 2nd. - - - - - | 2 | 5 | 195 | 175 | 3 | 4 | 6 | 9 | | | |
| Chippenham, *Wilts.* 93 - | 2 | 5 | 260 | 201 | 4 | 6 | 6 | 10 | 10 | 12 | |
| Frome, *Som.* 105 - - | 4 | 4 | 222 | 192 | 4 | 4 | 8 | 8 | 8 | | |
| Marshfield, *Gloster.* 102 - | 2 | 5 | 185 | 167 | 5 | 6 | 6 | 8 | 9 | | |
| Trowbridge, *Wilts.* 98 - | 3 | 5 | 249 | 212 | 3 | 3 | 4 | 5 | 6 | 8 | |
| BEDFORD.‡ | | | | | | | | | | | |
| Bedford, *Bedford*, 50 - | 3 | 5 | 275 | 125 | 8 | 9 | 12 | 14 | 14 | | |
| Bishop Stortford, *Hts.* 30 | 4 | 5 | 206 | 144 | 4 | 4 | 4 | 4 | 4 | | |
| Dunmow, *Essex*, 38 - - | 2 | 6 | 309 | 217 | 4 | 5 | 5 | 7 | 7 | 8 | 9 |
| Baldock, *Herts*, 37 - - | 4 | 4 | 300 | 104 | 4 | 5 | 5 | 6 | 8 | 11 | |
| Towcester, *Northamp.* 60 - | 2 | 6 | 314 | 183 | 6 | 7 | 7 | 8 | 11 | 16 | |
| BRISTOL.§ | | | | | | | | | | | |
| Bristol, 1st. *Som.* 119 - | 7 | | 31 | 24 | 2 | | | | | | |
| Ditto, 2nd. - - - - - | 6 | 1 | 83 | 2 | 2 | | | | | | |
| Ditto, 3rd. - - - - - - | 4 | 3 | 163 | 152 | 1 | 4 | 4 | 5 | | | |
| Ditto, 4th. - - - - - - | 5 | | 21 | | | | | | | | |
| Nailseaheath, *Som.* - - | 1 | 5 | 297 | 91 | 8 | 8 | 11 | 11 | 13 | | |
| Wells, *Som.* 123 - - - | 3 | 6 | 302 | 120 | 5 | 6 | 6 | 7 | 8 | 10 | |
| CAMBRIDGE.‖ | | | | | | | | | | | |
| Cambridge, *Camb.* 51 - | 4 | 5 | 308 | 212 | 2 | 2 | 3 | 6 | 7 | 11 | |
| Huntingdon, *Hunt.* 59 - | 3 | 6 | 427 | 280 | 6 | 7 | 7 | 10 | 10 | 12 | 13 |
| Soham, *Camb.* 69 - - | | 7 | 447 | 264 | 6 | 6 | 8 | 8 | 8 | 14 | |
| Royston, *Herts.* 38 - - | 2 | 5 | 325 | 178 | 4 | 5 | 7 | 14 | 17 | 17 | |
| Saffron Walden, *Essex*, 42 | 2 | 6 | 349 | 269 | 5 | 5 | 8 | 10 | 14 | | |

---

* *Barnstable.*—Dulverton, Dunster, Stogumber, Williton, Southmolton, Chumley, Bideford, Hartland, Stratton, Camelford, Launceston, Lifton, Holdsworthy, Sheepwash, Hatherleigh, Torrington, Ilfracombe, and Barnstaple. S. 350*l.*; C. 140*l.*; D. 46,353*l.* 3*s.* 7½d.; M. 269.

† *Bath.*—Bradford, Trowbridge, Westbury, Calne, Chippenham, Malmsbury, Sherston, Corsham, Marsfield, Keynsham, Frome, Warminster, Norton, and Bath. S. 400*l.*; C. 140*l.*; D. 129,798*l.* 14*s.* 5¾*d.*; M. 121.

‡ *Bedford (Baldock.)*—Olney, Newport, Towcester, Stony Stratford, Ampthill, Shefford, Sawbridgeworth, Hatfield, Dunmow, Thaxted, Stortford, Stevenage, Hitchin, Baldock, and Bedford. S. 350*l.*; C. 140*l.*; D. 216,099*l.* 0*s.* 11¼*d.*; M. 217.

§ *Bristol.*—Bristol, Chewton, Glastonbury, Shepton, Wells, Axbridge, and Nailseaheath collected at Wrington. S. 500*l.*; 1 C. 135*l.*; 1 C. 140*l.*; D. 370,828*l.* 10*s.* 0¾*d.*; M. 95.

‖ *Cambridge.*—Walden, Linton, Haverhill, Newmarket, Mildenhall, So-

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CANTERBURY.* | | | | | | | | | | | |
| Canterbury, *Kent*, 56 | 4 | 5 | 360 | 169 | 3 | 10 | 10 | 12 | 14 | | |
| Dover, *Kent*, 71 | 3 | 4 | 280 | 132 | 7 | 12 | 14 | | | | |
| Sandwich, *Kent*, 68 | 4 | 4 | 239 | 143 | 6 | 6 | 7 | 7 | 9 | 9 | 9 |
| Tenterden, *Kent*, 55 | 1 | 6 | 518 | 266 | 9 | 10 | 12 | 12 | 14 | 15 | |
| CHESTER.† | | | | | | | | | | | |
| Chester, *Chester*. 183 | 4 | 4 | 287 | 189 | 1 | 11 | 12 | 16 | | | |
| Ellesmere, *Salop* 175 | 2 | 6 | 308 | 298 | 4 | 5 | 8 | 10 | 16 | | |
| Nantwich, *Chester*. 164 | 1 | 6 | 337 | 296 | 6 | 7 | 8 | 9 | 11 | | |
| Oswestry, *Salop*. 171 | 3 | 6 | 348 | 319 | 3 | 5 | 6 | 9 | 9 | 12 | |
| Whitchurch, *Salop*. 161 | 1 | 7 | 432 | 309 | 6 | 10 | 12 | 12 | | | |
| Wrexham, *Denbigh*. 187 | 3 | 4 | 280 | 217 | 4 | 5 | | | | | |
| CORNWALL.‡ | | | | | | | | | | | |
| Bodmin, *Cornwall*, 234 | 1 | 8 | 431 | 225 | 7 | 7 | 7 | 12 | 12 | 14 | 15 |
| Penryn, *do.* 264 | 4 | 4 | 270 | 62 | 2 | 2 | 8 | 8 | 12 | 13 | |
| Penzance, *do.* 280 | 1 | 7 | 440 | 52 | 7 | 8 | 9 | 13 | 13 | 25 | |
| Truro, *do.* 257 | 2 | 7 | 385 | 188 | 3 | 8 | 9 | 11 | 14 | 15 | |
| COVENTRY.§ | | | | | | | | | | | |
| AshbydelaZouch, *Lei.* 115 | 1 | 7 | 344 | 283 | 4 | 5 | 7 | 8 | 13 | 15 | |
| Coventry, *Warwick*, 91 | 4 | 4 | 278 | 206 | 1 | 5 | 6 | 10 | | | |
| Leicester, *Leicester*, 98 | 6 | 3 | 202 | 174 | 1 | 4 | 5 | | | | |
| Loughboro', *do.* 109 | 2 | 5 | 239 | 199 | 3 | 4 | 6 | 6 | 10 | | |
| Nuneaton, *Warwick*, 100 | 1 | 6 | 309 | 280 | 4 | 6 | 6 | 12 | | | |
| Warwick, *do.* 93 | 3 | 7 | 326 | 275 | 1 | 3 | 3 | 5 | 7 | 11 | 15 |
| Hinckley, *Leicester*, 100 | 1 | 6 | 303 | 234 | 4 | 9 | 10 | 11 | 14 | | |
| CUMBERLAND.‖ | | | | | | | | | | | |
| Carlisle, *Cumberland*, 303 | 2 | 6 | 606 | 129 | 5 | 6 | 9 | 10 | 10 | | |
| Cockermouth, *do.* 303 | | 7 | 414 | 122 | 8 | 11 | 13 | 16 | 16 | | |
| Penrith, *do.* 285 | 1 | 7 | 516 | 190 | 2 | 10 | 11 | 14 | 22 | 26 | |
| Ulverstone, *Lanc* 266 | 2 | 7 | 395 | 299 | 3 | 6 | 7 | 10 | 12 | 16 | 21 |
| Whitehaven, *Cum.*317 | 2 | 6 | 308 | 136 | 6 | 8 | 8 | 18 | 26 | | |

---

ham, Ely, Caxton, Potton, Biggleswade, St. Neot's, Kimbolton, Godmanchester collected at Huntingdon, Ramsay, St. Ives, Buntingford, Royston, and Cambridge. S. 350*l.*: C. 140*l.*; D. 204,952*l.* 2*s.* 1½*d.*; M. 212.

* *Canterbury, (Dover)* — Romney, Cranbrook, Goudhurst, Tenterden, Ashford, Wye, Hythe, Folkestone, Elham, Faversham, Canterbury, Ramsgate, Margate, Sandwich, Deal and Dover. S. 450*l.*; C. 140*l.*; D. 159,721*l.* 2*s.* 7¾*d.*; M. 218.

† *Chester.*—Wrexham. Ellesmere, Overton, Llangollen, Oswestry, Wem, Hodnett, Drayton, Betley, Nantwich, Whitchurch, Malpas, Birkenhead, Neston, and Chester. S. 400*l.*; C. 140*l.*; D. 97,321*l.* 5*s.* 11¼*d.*; M. 173.

‡ *Cornwall, (Falmouth.)*—Mitchell, St. Columb, Padstow, Wadebridge, Bodmin, Lostwithiel, Fowey, St. Austle, Grampound, Tregony, Truro, Redruth, St. Ives, Penzance, Marketjew, Helston, Penryn, and Falmouth. S. 400*l.*; C. 140*l.*; D. 41,675*l.* 12*s.* 11¾*d.*; M. 176.

§ *Coventry.* — Kenilworth, Warwick, Solihull, Lutterworth, Hinckley, Leicester, Mountsorrell, Loughborough, Kegworth, Ashby, Bosworth, Polesworth, Atherstone, Nuneaton, and Coventry. S. 400*l.*; C. 140*l.*; D. 149,719*l.* 15*s.* 10*d.*; M. 162.

‖ *Cumberland, (Whitehaven).* — Ireby, Wigton, Carlisle, Longtown, Brampton, Kirkoswald, Appleby, Brough, Kirkby Stephen, Shap, Penrith, Keswick, Ambleside, Hawkshead, Cartmel, Ulverstone, Dalton,

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DERBY.* | | | | | | | | | | | |
| Derby, *Derby*, 126 - - | 5 | 4 | 254 | 213 | 5 | 5 | 7 | 8 | | | |
| Mansfield, *Notting.* 138. | 2 | 5 | 278 | 256 | 2 | 3 | 9 | 12 | 12 | | |
| Nottingham, 1st. *Not.* 124 | 3 | 4 | 194 | 176 | 2 | 8 | 8 | 13 | | | |
| Ditto, 2nd - - - - - - | 3 | 5 | 232 | 184 | 2 | 4 | 5 | 6 | 10 | | |
| Ditto, 3rd. - - - - - - | 4 | 4 | 231 | 212 | 3 | 5 | 8 | 14 | 14 | | |
| Wirksworth, *Derby*, 141 | 2 | 6 | 407 | 377 | 3 | 6 | 8 | 8 | 10 | 10 | |
| DORSET.† | | | | | | | | | | | |
| Blandford, *Dorset*, 104 - | 1 | 6 | 342 | 198 | 4 | 5 | 8 | 14 | 14 | | |
| Bridport, *do.* 135 - | 2 | 5 | 319 | 117 | 7 | 9 | 10 | 10 | 12 | | |
| Dorchester, *do.* 120 - | 3 | 4 | 229 | 122 | 5 | 8 | 8 | 8 | | | |
| Shaftesbury, *do.* 101 - | 1 | 6 | 318 | 176 | 1 | 8 | 9 | 9 | 13 | 14 | |
| Wincanton, *Somerset*, 108 | 1 | 6 | 316 | 118 | 5 | 5 | 6 | 9 | 10 | 11 | |
| DURHAM.‡ | | | | | | | | | | | |
| Barnard Castle, *Dur.* 249 | 1 | 7 | 385 | 273 | 6 | 6 | 12 | 16 | 22 | 28 | |
| Durham, *Durham*, 258 - | 2 | 6 | 331 | 235 | 4 | 6 | 7 | 7 | 11 | | |
| Hexham, *Northum.* 283 | 1 | 6 | 590 | 135 | 4 | 7 | 11 | 12 | 16 | 24 | |
| South Shields, *Dur.* 277 | 5 | 1 | 85 | 67 | | | | | | | |
| Sunderland, 1st. *Dur.* 268 | 6 | 1 | 88 | 52 | 1 | 3 | | | | | |
| Ditto, 2nd. - - - - - | 6 | 2 | 129 | 77 | 1 | 1 | 1 | 3 | 6 | 7 | |
| ESSEX.§ | | | | | | | | | | | |
| Braintree, *Essex*, 40 - | 3 | 5 | 268 | 172 | 7 | 8 | 8 | 8 | 10 | 11 | |
| Chelmsford, *do.* 29 - | 3 | 6 | 353 | 131 | 2 | 3 | 4 | 6 | 9 | 10 | 15 |
| Colchester, *do.* 51 - | 5 | 3 | 215 | 109 | 2 | 2 | 2 | 3 | 4 | 10 | |
| Manningtree, *do.* 60 - | 1 | 6 | 299 | 157 | 5 | 5 | 12 | 12 | 14 | | |
| Rayleigh, *do.* 36 - | | 7 | 421 | 39 | 6 | 6 | 11 | 15 | 16 | 18 | |
| EXETER.‖ | | | | | | | | | | | |
| Crediton, *Devon.* 180 - | 1 | 6 | 339 | 300 | 7 | 13 | 13 | 15 | 18 | | |
| Exeter, 1st. *Devon.* 173 | 6 | | 74 | 64 | | | | | | | |
| Ditto, 2nd. - - - - - | 3 | 3 | 121 | 106 | 2 | 6 | 11 | 11 | | | |
| Honiton, *Devon.* 156 - | 2 | 7 | 302 | 262 | 5 | 6 | 7 | 8 | 8 | 9 | 9 |
| Tiverton, *Devon.* 166 - | 2 | 5 | 270 | 199 | 5 | 7 | 7 | 9 | 11 | | |
| Topsham, *Devon.* 170 - | 2 | 5 | 207 | 173 | 4 | 7 | 10 | 10 | 12 | | |

---

Broughton, Bootle. Ravenglass, Egremont, Cockermouth, Maryport, Workington, and Whitehaven. S. 400*l.*; C. 140*l.*; D. 57,896*l.* 12*s.* 0*d.*; M. 305.

* *Derby, (Nottingham.)*—Nottingham, 1st. 2nd. and 3rd., Bingham, Southwell, Mansfield, Alfreton, Wirksworth, Ashbourn, and Derby. S. 350*l.*; C. 140*l.*; D. 128,290*l.* 6*s.* 0¼*d.*; M. 113.

† *Dorset, (Weymouth.)*—Sturminster, Mere, Hindon, Shaftesbury, Cranborne, Blandford, Bere, Bridport, Lyme, Beaminster, Evershot, Castle Carey, Bruton, Wincanton, Stalbridge, Milborne Port, Cerne Abbas, Dorchester, and Weymouth. S. 350*l*; C. 140*l.*; D. 63,604*l.* 17*s.* 4*d.*; M. 264.

‡ *Durham, (Sunderland.)*—South Shields, Hexham, Haltwhistle, Alston, Wolsingham, Barnard Castle, Bishop's Auckland, Sunderland, and Durham, 1st. and 2nd. S. 400*l.*; C. 140*l.*; D 257,340*l.* 10*s.* 5¾*d.*; M. 153.

§ *Essex, (Colchester.)*—Maldon, Rayleigh, Billericay, Grays, Ingatestone, Chelmsford, Witham, Manningtree, Harwich, Coggeshall, Halstead, Braintree, and Colchester. S. 450*l.* C. 140*l.*; D. 230,045*l.* 12*s.* 0*d.*; M. 187.

‖ *Exeter.*—Silverton, Bampton, Tiverton, Ottery, Honiton, Axminster, Collyton, Sidmouth, Exmouth, Topsham, Teignmouth, Chudleigh, Moreton, Chagford, Okehampton, Bow, Crediton, Bradninch, and Exeter, S. 400*l.*; C. 140*l.*; D. 80,014*l.* 8*s.* 2¾*d.*; M. 200.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GLOUCESTER.* | | | | | | | | | | | | |
| Cheltenham, *Glou.* 95 | 6 | 3 | 244 | 137 | 1 | 2 | 9 | 9 | 9 | 9 | | |
| Cirencester, *Glou.* 88 | 3 | 5 | 248 | 186 | 1 | 6 | 7 | 8 | 8 | 10 | | |
| Gloucester, *Glou.* 107 | 5 | 3 | 256 | 97 | 9 | 10 | | | | | | |
| Stroud, *Glou.* 93 | 1 | 7 | 358 | 216 | 2 | 4 | 4 | 5 | 5 | 5 | 8 | |
| Wotton, *Gloucester,* 107 | 1 | 7 | 389 | 226 | 4 | 6 | 6 | 8 | 8 | 10 | 11 | |
| Moreton, *Gloucester,* 82 | 1 | 7 | 299 | 224 | 4 | 7 | 8 | 8 | 8 | 11 | 15 | |
| GRANTHAM.† | | | | | | | | | | | | |
| Boston, *Lincoln,* 113 | 2 | 6 | 483 | 85 | 6 | 10 | 12 | 14 | 19 | | | |
| Grantham, *Lincoln,* 110 | 3 | 5 | 339 | 131 | 10 | 14 | 14 | 14 | | | | |
| Newark, *Notts. do.* 125 | 4 | 4 | 276 | 124 | 2 | 6 | 8 | | | | | |
| Peterborough, *North.* 77 | 2 | 5 | 387 | 115 | 6 | 8 | 10 | 20 | 20 | | | |
| Stamford, *Lincoln,* 89 | 2 | 6 | 228 | 103 | 8 | 11 | 14 | | | | | |
| Wisbeach, *Cambridge,* 95 | 1 | 6 | 526 | 27 | 8 | 10 | 12 | 15 | 20 | | | |
| HALIFAX.‡ | | | | | | | | | | | | |
| Barnsley, *York,* 172 | 1 | 7 | 339 | 297 | 3 | 4 | 5 | 6 | 7 | 9 | 10 | |
| Burnley, *Lancashire,* 210 | 1 | 6 | 402 | 319 | 3 | 6 | 6 | 7 | 11 | | | |
| Elland, *Yorkshire,* 194 | 3 | 5 | 461 | 340 | 4 | 4 | 4 | 5 | 6 | 8 | | |
| Halifax, *York,* 197 | 4 | 5 | 290 | 237 | 1 | 3 | 3 | 5 | 8 | | | |
| Huddersfield, *York,* 189 | 2 | 8 | 587 | 361 | 1 | 2 | 2 | 5 | 5 | 6 | 6 | 6 |
| Skipton, *York,* 222 | 2 | 6 | 380 | 319 | 6 | 8 | 10 | 10 | 11 | 14 | 16 | |
| HANTS.§ | | | | | | | | | | | | |
| Chichester, *Sussex,* 62 | 3 | 4 | 320 | 227 | 2 | 5 | 7 | 14 | 14 | | | |
| Fareham, *Hants,* 73 | 3 | 4 | 237 | 110 | 3 | 4 | 6 | 9 | 11 | | | |
| Guildford, *Surrey,* 29 | 2 | 5 | 305 | 207 | 5 | 7 | 10 | 10 | 11 | | | |
| Petersfield, *Hants,* 54 | | 6 | 287 | 133 | 5 | 9 | 9 | 10 | 12 | | | |
| Portsmouth, *Hants,* 72 | 6 | 1 | 82 | 54 | 1 | 1 | 2 | 2 | 2 | | | |
| HEREFORD.‖ | | | | | | | | | | | | |
| Chepstow, *Monmouth,* 130 | 1 | 6 | 353 | 320 | 5 | 6 | 7 | 14 | 17 | | | |
| Hereford, *Hereford,* 137 | 4 | 4 | 366 | 296 | 2 | 2 | 7 | 7 | | | | |
| Leominster, *Heref.* 137 | 2 | 5 | 287 | 231 | 8 | 9 | 12 | 12 | | | | |
| Ludlow, *Salop,* 143 | 2 | 6 | 295 | 252 | 9 | 9 | 9 | 11 | 11 | | | |
| Monmouth, *Mon.* 130 | 1 | 6 | 354 | 306 | 4 | 7 | 8 | 8 | | | | |
| Ross, *Hereford,* 120 | 2 | 6 | 446 | 180 | 6 | 13 | 13 | 13 | 19 | | | |

---

* *Gloucester.*—Winchcomb, Campden, Shipston, Moreton. Stow, Cirencester, Cricklade, Tetbury, Dursley, Berkeley, Thornbury, Sodbury, Wickwar, Wotton, Hampton, Stroud, Painswick, Tewkesbury, Cheltenham, Newent, and Gloucester. S. 400*l.*; C. 140*l.*; D. 111,720*l.* 17*s.* 0*d.*; M. 235.

† *Grantham, (Stamford.)*—Peterborough, Whittlesea, March, Upwell, Wisbeach, Holbeach, Spalding, Deeping, Bourn, Falkingham, Donnington, Boston, Tattershall, Sleaford, Newark, and Stamford, Grantham. S. 400*l.*; C. 140*l.*; D. 178,778*l.* 14*s.* 4¼*d.*; M. 226.

‡ *Halifax.*—Barnsley, Huddersfield, Keighley, Skipton, Settle, Gisburne, Colne, Burnley, and Elland collected at Halifax. S. 400*l.*; C. 140*l.*; D. 97,249*l.* 5*s.* 6*d.*; M. 139.

§ *Hants, (Portsmouth.)*—Hambledon, Petersfield, Farnham, Guilford, Godalming, Haslemere, Midhurst, Petworth, Chichester, Havant, Fareham, Tichfield, Gosport, and Portsmouth. S. 400*l.*; C. 140*l.*; D. 99,508*l.* 14*s.* 2¾*d.*; M. 124.

‖ *Hereford.*—Bromyard, Tenbury, Cleobury, Ludlow, Leominster, Weobly, Monmouth, Coleford, Chepstow, Lidney, Newnham, Dean, Ross, Ledbury and Hereford. S. 350*l.*; C. 140.; D. 80,707*l.* 7*s.* 3¾*d.*; M. 192.

| | D. | R. | Incl. | Excl: | From Residence. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HERTFORD.[*] | | | | | | | | | | | | |
| Barnet, *Herts.* 10 | 2 | 4 | 250 | 105 | 6 | 8 | 8 | 9 | 9 | | | |
| Bromley, by Bow, *Mid.* 4 | 2 | 1 | 54 | 27 | 1 | 2 | | | | | | |
| Romford, *Essex,* 12 | 1 | 5 | 293 | 178 | 3 | 6 | 7 | 12 | 12 | | | |
| Somers' Town, *Mid.* 2 | 4 | 4 | 178 | 97 | 3 | 3 | 3 | 4 | | | | |
| Hoddesdon; *Herts.* 17 | 1 | 5 | 257 | 96 | 2 | 7 | 7 | 9 | 13 | | | |
| Ware, *Herts.* 21 | 7 | 1 | 94 | 55 | 3 | 3 | | | | | | |
| HULL.[†] | | | | | | | | | | | | |
| Beverley, *York,* 180 | 3 | 6 | 524 | 281 | 7 | 10 | 13 | 17 | 17 | 19 | | |
| Hull, 1st. *York,* 171 | 5 | 2 | 138 | 65 | 5 | 15 | | | | | | |
| Ditto, 2nd. | 3 | 2 | 221 | 92 | 6 | 16 | | | | | | |
| Scarborough, *York,* 214 | 3 | 5 | 388 | 193 | 8 | 18 | 18 | 23 | 23 | 23 | | |
| ISLE OF WIGHT.[‡] | | | | | | | | | | | | |
| Newport, *Hants.* 100 | 4 | 3 | 241 | 116 | 4 | 5 | 8 | 9 | | | | |
| Poole, *Dorset.* 106 | 3 | 4 | 271 | 61 | 6 | 6 | 6 | 10 | 14 | | | |
| Ringwood, *Hants.* 91 | 2 | 4 | 298 | 181 | 1 | 7 | 10 | 13 | 15 | | | |
| Southampton, *Hants.* 77 | 3 | 3 | 243 | 101 | 4 | 4 | 14 | | | | | |
| Winchester, *Hants.* 62 | 2 | 5 | 267 | 179 | 5 | 8 | 10 | 10 | | | | |
| LANCASTER.[§] | | | | | | | | | | | | |
| Blackburn, *Lancas.* 210 | 2 | 5 | 337 | 260 | 2 | 4 | 4 | 6 | 9 | | | |
| Kendal, *West.* 261 | 2 | 6 | 399 | 299 | 4 | 6 | 8 | 11 | 11 | | | |
| Lancaster, *Lancash.* 239 | 3 | 5 | 299 | 268 | 1 | 4 | 8 | 9 | 15 | | | |
| Preston, *Lancashire,* 218 | 5 | 4 | 257 | 204 | 7 | 9 | 13 | | | | | |
| Garstang, *Lancash.* 228 | | 7 | 438 | 342 | 7 | 7 | 12 | 20 | 20 | 24 | | |
| LEEDS.[‖] | | | | | | | | | | | | |
| Bradford, *York.* 197 | 3 | 7 | 338 | 314 | 1 | 1 | 3 | 3 | 5 | 5 | 6 | 9 |
| Leeds, 1st. *York.* 196 | 6 | 1 | 79 | 75 | | | | | | | | |
| Leeds, 2nd. (*Hunslet.*) | 7 | 1 | 71 | 58 | 2 | 2 | 2 | 2 | 4 | | | |
| Leeds, 3rd | 4 | 4 | 215 | 172 | 2 | 4 | 10 | 10 | 10 | | | |
| Armley, *near Leeds,* 199 | 3 | 6 | 260 | 222 | 1 | 2 | 3 | 5 | 5 | 6 | 6 | 8 |
| Wakefield, 1st., *York.* 187 | 5 | 4 | 181 | 178 | 4 | 4 | 5 | | | | | |
| Wakefield, 2nd. | 4 | 4 | 207 | 189 | 4 | 7 | 8 | 8 | 9 | | | |

---

[*] *Hertford,* (*No.* 1, *Durham Place East, Hackney Road.*)—Hoddesdon, Ware, Hertford, Hatfield, Barnet, Edgeware, Barking, Romford, Brentwood, Ongar, Harlow, Epping, Waltham, Enfield; and Somers' Town and Bromley are districts, but collected at the chief office. S. 400*l.*; C. 145*l.*; D. 760,885*l.* 19*s.* 6½*d.*; M. 149.

[†] *Hull.*—South Cave, Market Weighton, Pocklington, Malton, Scarborough, Hunmanby, Bridlington, Driffield, Beverley, Hornsea, Patrington Hedon, and Hull. S. 400*l.*; C. 140*l.*; D. 92,518*l.* 4*s.* 3½*d.*; M. 296.

[‡] *Isle of Wight,* (*Southampton.*)—Fordingbridge, Ringwood, Poole. Corfe Castle, Wareham, Wimborne, Christchurch, Lymington, Yarmouth, Newport, Ryde, Cowes, Southampton, Waltham, Alresford, and Winchester. S. 450*l.*; C. 140*l.*; D. 83,062*l.* 5*s.* 5½*d.*; M. 219.

[§] *Lancaster.*—Hornby, Kirkby, Sedbergh, Kendal, Milnthorp, Burton, Garstang, Poulton, Kirkham, Preston, Blackburn, Haslingden, Clithero, and Lancaster. S. 400*l.*; C. 140*l.*; D. 89,543*l.* 4*s.* 7*d.*; M. 195.

[‖] *Leeds.*—Bradford, Bingley, Otley, Leeds, Wakefield; and Armley district collected in Leeds. S. 450*l.*; 2 C. 140*l.*; D. 297,745*l.* 8*s.* 0¾*d.*; M. 54.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LICHFIELD.* | | | | | | | | | | | | |
| Birmingham, 1st. *War.* 108 | 6 | 1 | 57 | 57 | 1 | | | | | | | |
| Ditto, 2nd. | 7 | 1 | 89 | 77 | 4 | | | | | | | |
| Ditto, 3rd. | 7 | 1 | 67 | 54 | 1 | | | | | | | |
| Ditto, 4th. | 7 | | 40 | 40 | | | | | | | | |
| Ditto, 5th. | 4 | 4 | 187 | 136 | 1 | 2 | 4 | 10 | 10 | | | |
| Lichfield, *Staffordsh.* 119 | 4 | 5 | 278 | 193 | 2 | 3 | 8 | 8 | 8 | 8 | | |
| Walsall, *Staffordsh.* 117 | 4 | 4 | 184 | 171 | 1 | 4 | 4 | 9 | | | | |
| LINCOLN.† | | | | | | | | | | | | |
| Brigg, *Lincolnsh.* 153 | 1 | 6 | 437 | 241 | 10 | 10 | 10 | 12 | 14 | | | |
| Gainsbro' *Lincolnsh.* 147 | 3 | 5 | 347 | 277 | 6 | 6 | 12 | 14 | 19 | | | |
| Horncastle, *Lincoln.* 135 | 1 | 7 | 476 | 345 | 7 | 11 | 11 | 18 | 18 | 20 | | |
| Lincoln, *Lincolnsh.* 129 | 4 | 3 | 301 | 100 | 7 | 7 | 10 | | | | | |
| Louth, *Lincolnsh.* 144 | 3 | 5 | 350 | 193 | 10 | 15 | 15 | 17 | 17 | | | |
| Retford, *Nottingham,* 141 | 2 | 5 | 279 | 264 | 8 | 10 | 10 | 14 | 15 | | | |
| Worksop, *Notting.* 147 | 3 | 4 | 200 | 191 | 4 | 4 | 7 | 7 | | | | |
| LIVERPOOL.‡ | | | | | | | | | | | | |
| Liverpool, 1st., *Lan.* 206 | 6 | | 29 | 20 | 1 | 1 | | | | | | |
| Ditto, 2nd, | 6 | | 28 | 22 | | | | | | | | |
| Ditto, 3rd. | 6 | | 24 | 19 | | | | | | | | |
| Ditto 4th. | 6 | | 24 | 24 | | | | | | | | |
| Ditto, 5th. | 6 | | 24 | 15 | | | | | | | | |
| Ditto, 6th. | 4 | 3 | 199 | 29 | 2 | 2 | 4 | 4 | 7 | | | |
| LYNN.§ | | | | | | | | | | | | |
| Dereham, *Norfolk,* 101 | 1 | 7 | 522 | 147 | 4 | 7 | 10 | 10 | 12 | 12 | 13 | |
| Lynn, *Norfolk,* 97 | 1 | 7 | 387 | 180 | 5 | 8 | 12 | 12 | 15 | | | |
| Thetford, *Norfolk,* 80 | 2 | 5 | 357 | 139 | 7 | 13 | 15 | 18 | 21 | | | |
| Wells, *Norfolk,* 119 | 1 | 6 | 328 | 196 | 7 | 10 | 10 | 10 | 12 | | | |
| MANCHESTER.\|\| | | | | | | | | | | | | |
| Ashton, *Lanc.* 186 | 3 | 7 | 439 | 404 | 2 | 4 | 4 | 5 | 5 | 6 | 9 | 10 |
| Manchester, 1st. *Lan.* 182 | 7 | 1 | 123 | 113 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | |
| Ditto, 2nd. | 4 | 5 | 275 | 245 | 1 | 1 | 3 | 4 | 6 | 6 | | |
| Ditto, 3rd. | 6 | 3 | 245 | 197 | 1 | 2 | 2 | 3 | 3 | 4 | | |
| Rochdale, *Lancash.* 199 | 3 | 5 | 329 | 301 | 4 | 4 | 5 | 9 | | | | |
| NEWCASTLE.* | | | | | | | | | | | | |
| Berwick, *North.* 334 | 3 | 6 | 433 | 55 | 8 | 15 | 20 | 30 | 30 | 30 | 30 | |

---

* *Lichfield,* (*Birmingham.*)—Birmingham, Walsall, Sutton, Lichfield, Tamworth, and Coleshill. S. 400*l.*; C. 140*l.*; D. 201,955*l.* 11*s.* 6½*d.*; M. 52.

† *Lincoln.*—Tuxford, Retford, Worksop, Blythe, Crowle, Epworth, Gainsborough. Kirton, Winterton, Barton, Brigg, Caistor, Grimsby, Louth, Alford, Burgh, Spilsby, Horncastle, Wragby, Raisin, and Lincoln. S. 400*l.* C. 140*l.*; D. 145,743*l.* 7*s.* 6*d.*; M. 259.

‡ *Liverpool.*—Liverpool. S. 550*l.*; 1 C. 130*l.*; 2 C. 115*l.*; 432,681*l.* 0*s.* 0½*d.*

§ *Lynn.*—Downham, Stoke Ferry, Brandon. Thetford, Harling, Diss, Buckenham, Wymondham, Hingham, Watton, Swaffham, Dereham, Reepham, Holt, Fakenham, Wells, Burnham, Snettisham, and Lynn. S. 400*l.*; C. 140*l.*; D. 119,625*l.* 16*s.* 7¾*d.*; M. 211.

|| *Manchester.*—Rochdale, Oldham, Ashton, Middleton, Salford, and Manchester. S. 450*l.*; C. 140*l.*; D. 141,931*l.* 15*s.* 6½*d.*; M. 64.

* *Newcastle on Tyne.*—Newcastle, Gateshead collected in Newcastle. Morpeth, Warkworth, Alnwick, Belford, Berwick, Wooler, Rothbury, and North Shields. S. 450*l.*; C. 140*l.*; D. 307,224*l.* 13*s.* 3½*d.*; M. 149.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Newcastle**, *continued*, | | | | | | | | | | | | |
| Gateshead, *Durham*, 270 | 5 | 5 | 313 | 129 | 2 | 3 | 5 | 8 | 16 | 16 | | |
| Morpeth, *Northumb.* 285 | 1 | 7 | 411 | 48 | 10 | 11 | 11 | 11 | 15 | 16 | | |
| Newcastle, 1st. *North.* 276 | 3 | | 39 | 39 | | | | | | | | |
| Ditto, 2nd. - - - - | 6 | 2 | 134 | 99 | 2 | 2 | 2 | 2 | | | | |
| Ditto, 3rd. - - - - | 7 | 1 | 124 | 76 | 4 | 5 | 16 | | | | | |
| North Shields, *North.* 277 | 4 | 4 | 214 | 142 | 2 | 4 | 8 | 8 | 11 | 11 | | |
| **Northampton.**† | | | | | | | | | | | | |
| Daventry, *Northamp.* 72 | 1 | 6 | 260 | 164 | 4 | 5 | 6 | 8 | 8 | 10 | | |
| Bosworth, *Lei.* . . . . . . . 84 | 1 | 6 | 295 | 178 | 7 | 7 | 7 | 10 | 14 | 18 | | |
| Melton Mowbray, *Lei.* 105 | 1 | 5 | 282 | 182 | 6 | 7 | 7 | 10 | 14 | | | |
| Northampton, *Nhamp.* 66 | 4 | 4 | 201 | 156 | 3 | 3 | 4 | 8 | | | | |
| Oundle, *Northampton*, 77 | | 7 | 344 | 222 | 8 | 8 | 9 | 10 | 12 | | | |
| Uppingham, *Rutland*, 89 | 1 | 5 | 270 | 166 | 3 | 7 | 7 | 7 | 10 | | | |
| Wellingboro', *Nhamp.* 68 | 2 | 5 | 265 | 173 | 4 | 6 | 6 | 8 | 12 | | | |
| **Northwich.**‡ | | | | | | | | | | | | |
| Congleton, *Cheshire*, 162 | 3 | 4 | 397 | 293 | 2 | 8 | 11 | 12 | 15 | | | |
| Frodsham, *Cheshire*, 195 | 2 | 5 | 354 | 223 | 6 | 6 | 9 | 12 | 12 | 19 | | |
| Macclesfield, *Chesh.* 176 | 3 | 6 | 463 | 344 | 1 | 3 | 3 | 8 | 11 | 17 | | |
| Knutsford, *Cheshire*, 176 | 1 | 7 | 270 | 229 | 7 | 7 | 7 | 7 | 10 | 12 | | |
| Stockport, *Cheshire*, 179 | 3 | 5 | 320 | 247 | 1 | 2 | 3 | 5 | 9 | | | |
| Warrington, *Lancash.* 188 | 8 | 1 | 98 | 71 | | | | | | | | |
| **Norwich.**§ | | | | | | | | | | | | |
| Bungay, *Suffolk*, 109 - | 2 | 6 | 426 | 109 | 2 | 5 | 6 | 6 | 8 | 13 | 13 | |
| Coltishall, *Norfolk* 119 | | 9 | 547 | 216 | 4 | 8 | 8 | 3 | 9 | 10 | 10 | 13 |
| Norwich, *Norfolk*, 111 - | 8 | 1 | 116 | 47 | | | | | | | | |
| Yarmouth, *Norfolk*, 124 | 4 | 3 | 187 | 96 | 3 | 3 | 10 | | | | | |
| **Oxford.**‖ | | | | | | | | | | | | |
| Banbury, *Oxford*, 75 - - | 1 | 7 | 300 | 270 | 4 | 4 | 6 | 7 | 8 | 12 | | |
| Buckingham, *Bucks*, 58 | 2 | 5 | 269 | 218 | 8 | 9 | 9 | 12 | 12 | | | |
| Burford, *Oxford*, 73 - - | 1 | 6 | 269 | 241 | 5 | 5 | 8 | 10 | 10 | 12 | | |
| Shrivenham, *Berks.* 68 | | 6 | 292 | 226 | 4 | 6 | 7 | 9 | 13 | | | |
| Oxford, 55 - - - - | 3 | 4 | 202 | 143 | 2 | 3 | 8 | 9 | | | | |
| Witney, *Oxford*, 66 - - | 2 | 5 | 242 | 194 | 6 | 7 | 14 | 15 | 20 | | | |

---

† *Northampton.*—Wellingborough, Higham, Thrapston, Oundle, Cliffe, Weldon, Kettering, Rowell, Harborough, Melton, Oakham, Uppingham, Hallaton, Bosworth collected at Harborough, Haddon, Rugby, Southam Daventry, and Northampton. S. 350*l.*; C. 140*l.*; D. 109,698*l.* 4*s.* 0½*d.*; M. 195.

‡ *Northwich,* (*Knutsford.*)—Warrington, Runcorn, Frodsham, Tarporley, Northwich, Knutsford, Altrincham, Stockport, Macclesfield, Longnor, Leek, Congleton, Sandbach, and Middlewich. S. 450*l.*; C. 140*l.*; D. 174,594*l.* 9*s.* 0¾*d.*; M. 144.

§ *Norwich.*—Walsham, Aylesham, Loddon, Bungay, Harleston, Beccles, Lowestoft, Yarmouth, and Norwich. S. 450*l.*; C. 140*l.*; D. 182,477*l.* 15*s.* 7½*d.*; M. 115.

‖ *Oxford.*—Bicester, Buckingham, Winslow. Brackley, Banbury. Deddington, Chipping Norton. Charlbury, Woodstock, Bampton, Farringdon, Lambourn, Swindon, Wootton, Highworth, Lechlade, Fairford, Northleach, Burford, Witney, and Oxford. S. 350*l.*; C. 140*l.*; D. 94,427*l.* 2*s.* 8¼*d.*; M. 208.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PLYMOUTH.* | | | | | | | | | | | |
| Devonport, *Devon.* 218 | 3 | 3 | 190 | 145 | 7 | 9 | | | | | |
| Kingsbridge, *Devon.* 207 | 3 | 4 | 261 | 240 | 4 | 5 | 8 | 14 | | | |
| Callington, *Cornwall,* 214 | 2 | 5 | 463 | 317 | 7 | 9 | 9 | 9 | 10 | 17 | |
| Plymouth, *Devon.* 216 - | 6 | | 45 | 37 | 1 | | | | | | |
| Totness, *Devon.* 196 - - | 3 | 5 | 311 | 244 | 7 | 8 | 8 | 10 | 11 | 12 | |
| READING.† | | | | | | | | | | | |
| Abingdon, *Berks.* 56 - | 3 | 4 | 233 | 151 | 3 | 3 | 5 | 10 | 10 | | |
| Henley, *Oxford,* 35 - - | 4 | 3 | 278 | 153 | 4 | 5 | 8 | 8 | | | |
| Newbury, *Berks.* 57 - - | 2 | 5 | 262 | 157 | 2 | 4 | 6 | 10 | | | |
| Reading, *Berks.* 39 - - | 3 | 5 | 322 | 98 | 5 | 6 | 7 | 9 | | | |
| Wallingford, *Berks.* 45 | 1 | 5 | 229 | 145 | 3 | 3 | 5 | 7 | | | |
| Windsor, *Berks.* 23 - - | 3 | 5 | 209 | 64 | 3 | 5 | 5 | 7 | 10 | 12 | |
| ROCHESTER.‡ | | | | | | | | | | | |
| Dartford, *Kent,* 15 - - | 3 | 5 | 253 | 128 | 4 | 7 | 8 | 8 | 9 | 10 | |
| Deptford, *Kent,* 4 - - | 8 | 1 | 119 | 53 | 2 | 2 | 2 | 3 | 4 | 4 | |
| Maidstone, *Kent,* 34 - - | 4 | 3 | 223 | 123 | 4 | 7 | 10 | | | | |
| Malling, *Kent,* 29 - - | 3 | 4 | 241 | 166 | 2 | 4 | 7 | 8 | 8 | 11 | |
| Rochester, *Kent,* 29 - - | 4 | 5 | 298 | 80 | 2 | 2 | 2 | 4 | 11 | 11 | 21 |
| Seven Oaks, *Kent,* 24 - | 1 | 6 | 377 | 197 | 2 | 6 | 7 | 9 | 13 | 13 | |
| SALISBURY.§ | | | | | | | | | | | |
| Andover, *Hants.* 63 - - | 1 | 6 | 284 | 200 | 4 | 6 | 7 | 14 | 16 | | |
| Basingstoke, *Hants.* 45 | 3 | 6 | 410 | 216 | 3 | 8 | 8 | 10 | 12 | 12 | 14 |
| Devizes, *Wilts.* 88 - - | 3 | 4 | 234 | 189 | 1 | 6 | 6 | 7 | 12 | | |
| Marlbro', *Wilts.* 74 - - | 4 | 4 | 272 | 140 | 4 | 7 | 7 | 11 | 12 | 14 | |
| Romsey, *Hants.* 73 - - | 2 | 5 | 305 | 161 | 8 | 9 | 10 | 14 | | | |
| Sarum, *Wilts.* 81 - - | 3 | 4 | 212 | 180 | 3 | 8 | 13 | | | | |
| SALOP.‖ | | | | | | | | | | | |
| Broseley, *Salop.* 144 - | 4 | 3 | 219 | 82 | 2 | 4 | 4 | 5 | 16 | | |
| Newport, *Salop.* 140 - - | 1 | 6 | 327 | 301 | 3 | 6 | 7 | 9 | 9 | | |
| Salop, 1st., *Salop.* 153 - | 3 | 4 | 253 | 205 | 1 | 1 | 6 | 9 | 11 | | |
| Ditto, 2nd. - - - - | 2 | 5 | 284 | 248 | 5 | 7 | 8 | 13 | | | |
| Wellington, *Salop.* 142 | 4 | 5 | 252 | 241 | 1 | 3 | 4 | 4 | 4 | 8 | 8 |
| Bridgenorth, *Salop.* 138 | 2 | 5 | 288 | 254 | 4 | 6 | 7 | 12 | | | |

---

* *Plymouth.*—Totness, Ashburton, Newton, Torquay, Brixham, Dartmouth, Kingsbridge, Modbury, Saltash, Looe, Liskeard, Callington, Tavistock, Devonport, Plymton, and Plymouth. S. 450*l.*; C. 140*l.*; D. 121,931*l.* 18*s.* 3¼*d.*; M. 167.

† *Reading.*—Newbury, Ilsley, Wantage, Abingdon, Dorchester, Watlington, Wallingford, Henley, Marlow, Colnbrook, Windsor, Maidenhead, Wokenham, Aldermaston, and Reading. S. 350*l.*; C. 140*l.*; D. 168,150*l.* 7*s.* 7¼*d.*; M. 163.

‡ *Rochester.*—Deptford, Greenwich, Woolwich, St. Mary Cray, Dartford, Gravesend, Tunbridge, Seven Oaks, Westerham, Wrotham, Malling, Maidstone, Lenham, Milton, and Rochester. S. 450*l.*; C. 140*l.*; D. 244,250*l.* 19*s.* 11¾*d.*; M. 161.

§ *Sarum or Salisbury.*—Andover, Whitchurch, Kingsclere, Basingstoke, Odiham, Alton, Stockbridge, Lavington, Devizes, Marlborough, Hungerford, Bedwin, Pewsey, Amesbury, Wilton, Romsey, and Salisbury. S. 350*l.*; C. 140*l.*; D. 124,136*l.* 2*s.* 2¼*d.*; M. 223.

‖ *Salop,* (*Shrewsbury* ) — Stretton, Wenlock, Bridgenorth, Shiffnall, Broseley collected at Ironbridge, Newport, Eccleshall, Wellington, and Shrewsbury. S. 400*l.*; C. 140*l.*; D. 95,292*l.* 5*s.* 10*d.*; M. 121.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SHEFFIELD.* | | | | | | | | | | | |
| Chesterfield, *Derbysh.* 157 | 3 | 4 | 241 | 90 | 2 | 3 | 7 | 8 | | | |
| Doncaster, *York.* 164 - | 3 | 5 | 262 | 140 | 6 | 8 | 9 | 10 | | | |
| Rotherham, *York.* 160 - | 3 | 4 | 239 | 186 | 3 | 3 | 7 | 8 | | | |
| Sheffield, 1st. *York*, 163 | 5 | 2 | 193 | 126 | 2 | 2 | 6 | 6 | | | |
| Ditto, 2nd. - - - - - | 6 | 3 | 226 | 93 | 2 | 2 | 4 | 5 | | | |
| Tideswell, *Derby.* 161 - | | 7 | 543 | 271 | 8 | 8 | 9 | 9 | 12 | 17 | |
| STAFFORD.† | | | | | | | | | | | |
| Burton on Trent, *Staff.* 124 | 4 | 3 | 192 | 145 | 2 | 5 | | | | | |
| Hanley, *Staffordsh.* 151 | 4 | 4 | 253 | 193 | 2 | 2 | 4 | 4 | 4 | | |
| Newcastle, *Staff.* 149 - | 5 | 3 | 153 | 130 | 2 | 4 | 4 | 5 | 5 | | |
| Penkridge, *Staffordsh.* 130 | | 7 | 338 | 309 | 5 | 5 | 7 | 8 | 9 | 9 | |
| Stafford, *Stafford*, 141 - | 3 | 5 | 294 | 259 | 6 | 6 | 6 | 7 | 7 | | |
| Cheadle, *Stafford*, 143 - | 2 | 5 | 326 | 265 | 3 | 5 | 7 | 7 | 8 | | |
| Tutbury, *Stafford*, 136 - | 1 | 5 | 333 | 272 | 7 | 10 | 10 | 10 | 10 | | |
| STOURBRIDGE.‡ | | | | | | | | | | | |
| Bewdley, *Worcester*, 127 | 4 | 5 | 275 | 233 | 3 | 3 | 3 | 3 | 4 | 5 | 8 |
| Dudley, *Worcestersh.* 127 | 5 | 2 | 94 | 87 | 1 | 2 | | | | | |
| Spon Lane, 1st *Staff.* 114 | 2 | 5 | 186 | 167 | 3 | 3 | 4 | 4 | 4 | | |
| Ditto, 2nd, 112 - | 3 | 4 | 205 | 202 | 4 | 4 | 7 | 7 | 8 | | |
| Stourbridge, 1st. *Wor.* 123 | 6 | 1 | 103 | 95 | 2 | 2 | 3 | | | | |
| Ditto 2nd, (*Brettle Lane,*) 125 - - - - - - - | 1 | 6 | 189 | 181 | 2 | 2 | 4 | 4 | 4 | | |
| Bilston, *Staffordsh.* 120 | 1 | 7 | 265 | 209 | 3 | 3 | 4 | 4 | 4 | | |
| Wolverhampton, *Do.* 123 | 5 | 3 | 145 | 125 | 2 | 5 | | | | | |
| SUFFOLK.§ | | | | | | | | | | | |
| Bury, *Suffolk*, 71 - - | 2 | 5 | 278 | 149 | 6 | 7 | 10 | 10 | | | |
| Hadleigh, *Suffolk*, 61 - | 4 | 4 | 216 | 149 | 3 | 6 | 6 | 8 | 10 | 6 | |
| Ipswich, *Suffolk*, 69 - - | 6 | | 32 | 26 | | | | | | | |
| Stowmarket, *Suffolk*, 69 | 2 | 6 | 354 | 162 | 4 | 6 | 8 | 14 | 15 | | |
| Sudbury, *Suffolk*, 54 - - | 3 | 5 | 283 | 137 | 1 | 3 | 6 | 8 | 8 | 8 | 10 |
| Woodbridge, *Suffolk*, 77 | 3 | 5 | 364 | 206 | 5 | 8 | 9 | 9 | 13 | 14 | |
| Halesworth, *Suffolk*, 102 | 1 | 6 | 355 | 121 | 8 | 10 | 12 | 13 | 16 | | |
| SURREY.‖ | | | | | | | | | | | |
| Battersea, *Surrey*, 3¾ - | 6 | | 75 | 64 | 2 | 2 | 2 | 3 | 4 | | |
| Brentford, *Middlesex*, 7 | 4 | 2 | 101 | 72 | 1 | 2 | | | | | |

---

* *Sheffield.*—Tickhill, Bawtry, Doncaster; Rotherham, Dronfield, Chesterfield, Bakewell, Buxton, Tideswell, Hope, and Sheffield, 1st. and 2nd. S. 350*l.*; C. 140*l.*; D. 129,143*l.* 12*s.* 1¼*d.*; M. 113.

† *Stafford.*—Cheadle, Lane End, Stone, Hanley, Burslem, Newcastle, Rugeley, Bromley, Burton, Tutbury, Ultoxeter, Stafford, Penkridge, and Stafford. S. 350*l.*; C. 140*l.*; D. 105,948*l.* 2*s.* 7¾*d.*; M. 123.

‡ *Stourbridge.*—Sponlane, 1st. district collected at Westbromich, &c.; and Sponlane 2nd., at Smethwick, &c.; Wednesbury, Bilston, Dudley, Stourbridge, Wolverhampton, Halesowen, Kidderminster, Bewdley, and Kinver. S. 400*l.*; C. 140*l.*; D. 322,226*l.* 0*s.* 1*d.*; M. 87.

§ *Suffolk*, (*Ipswich.*)—Stowmarket, Bury St. Edmunds, Lavenham, Clare, Sudbury, Nayland, Needham, Ixworth, Botesdale, Eye, Debenham, Framlingham, Halesworth, Southwold, Saxmundham, Woodbridge, Hadleigh, Bildeston, and Ipswich. S. 450*l.*; C. 140*l.*; D 252,003*l.* 19*s.* 6¾*d.*; M. 216.

‖ *Surrey*, (*Brentford.*)—Staines, Chertsey, Woking, Kingston, Southwark,

| | D | R | Incl. | Excl: | From Residence. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SURREY, *continued.* | | | | | | | | | | |
| Chertsey, *Surrey*, 19 - | 1 | 6 | 366 | 226 | 4 | 5 | 5 | 7 | 9 | 10 |
| Croydon, *Surrey*, 10 - | 4 | 3 | 216 | 100 | 4 | 4 | 6 | 7 | 8 | |
| Kensington, *Surrey*, 2 - | 7 | | 74 | 48 | 2 | 2 | 2 | 3 | 5 | |
| Kingston, *Surrey*, 12 - | 6 | 1 | 118 | 82 | 4 | 5 | | | | |
| SUSSEX.* | | | | | | | | | | |
| Arundel, *Sussex*, 60 - - | 2 | 6 | 380 | 293 | 5 | 9 | 9 | 10 | 15 | 15 |
| Battle, *Sussex*, 56 - - | 1 | 6 | 443 | 351 | 6 | 6 | 7 | 8 | 13 | 16 |
| Brighton, *Sussex*, 55 - - | 4 | 4 | 266 | 218 | 2 | 6 | 10 | 15 | | |
| Dorking, *Sussex*, 23 - - | 2 | 5 | 470 | 331 | 5 | 6 | 7 | 14 | 14 | 14 |
| Lewes, *Sussex*, 50 - - | 2 | 6 | 314 | 197 | 3 | 3 | 8 | 9 | 10 | 16 |
| Tunbridge Wells, *Kent* 36 | 2 | 8 | 483 | 340 | 4 | 8 | 8 | 9 | 12 | 16 |
| UXBRIDGE.† | | | | | | | | | | |
| Aylesbury, *Bucks.* 39 - | 2 | 5 | 328 | 201 | 6 | 8 | 10 | 10 | 13 | |
| Hemel Hempstead, *Herts.* 23 - - - - - | 1 | 5 | 195 | 81 | 2 | 4 | 5 | 9 | 9 | |
| Leighton Buzzard, *Bdf.* 41 | 2 | 6 | 340 | 230 | 4 | 7 | 7 | 8 | 8 | 9 |
| Uxbridge, *Middlesex*, 15 | 1 | 6 | 343 | 118 | 4 | 4 | 5 | 8 | 11 | 11 |
| Wycombe, *Bucks* 28 - | 5 | 3 | 222 | 85 | 2 | 5 | 5 | 6 | 9 | |
| St. Albans, *Herts.* 21 - | 4 | 3 | 206 | 121 | 4 | 6 | 8 | 8 | 11 | |
| WALES EAST.‡ | | | | | | | | | | |
| Abergavenny, *Mon.* 146 | 3 | 7 | 480 | 475 | 5 | 5 | 6 | 10 | 10 | 11 |
| Brecon, *Brecon*, 171 - | 1 | 6 | 475 | 419 | 9 | 12 | 17 | 17 | | |
| Bridgend, *Glamorgan*, 181 | 1 | 7 | 466 | 428 | 7 | 10 | 12 | 13 | 19 | 25 |
| Cardiff, *Glamorgan*, 159 - | 3 | 5 | 339 | 316 | 3 | 12 | 12 | 12 | 15 | |
| Merthyr Tidvil, *Gla.* 171 | 1 | 7 | 368 | 122 | 3 | 8 | 8 | 10 | 13 | 18 |
| Swansea, *Glamorgan*, 206 | 3 | 6 | 414 | 387 | 4 | 4 | 5 | 12 | 12 | 12 |
| WALES MIDDLE.§ | | | | | | | | | | |
| Aberystwith, *Cardig.* 208 | 1 | 5 | 384 | 292 | 9 | 17 | 21 | | | |
| Dolgelley, *Merioneth*, 208 | | 7 | 462 | 174 | 11 | 18 | 18 | 19 | 19 | 19 |
| Kington, *Hereford*, 154 - | 1 | 6 | 381 | 340 | 5 | 7 | 14 | 14 | 19 | |
| Knighton, *Radnorsh.* 159 | 2 | 6 | 532 | 483 | 7 | 7 | 13 | 13 | 14 | 24 |
| Llanfyllin, *Montgom.* 182 | | 7 | 374 | 208 | 6 | 7 | 7 | 9 | 13 | 18 |
| Welshpool, *Mon.* 177 - | 2 | 7 | 438 | 347 | 5 | 8 | 14 | 14 | 14 | 28 |

---

Bromley, Croydon, Ewell, and Brentford. S. 400*l.*; C. 140*l.*; D. 767,298*l.* 11*s.* 2¾*d.* M. 109.

* *Sussex*, (*Lewes*).—East Grinstead, Tunbridge Wells, Wadhurst, Rye, Hastings, Battle, Hailsham, Shoreham, Steyning, Worthing, Arundel, Storrington, Pulborough, Horsham, Dorking, Reigate, Cuckfield, Brighton, and Lewes. S. 400*l.*; C. 140*l.*; D. 202,799*l.* 3*s.* 5¾*d*; M. 243.

† *Uxbridge.*—Watford, St. Alban's, Redbourn, Luton, Dunstable, Toddington, Woburn, Fenny Stratford, Leighton, Aylesbury, Thame, Risborough, Wendover, Tring, Ivinghoe, Berkhampstead, Hempstead, Rickmansworth, Chesham, Amersham, Wycomb, Beaconsfield and Uxbridge. S. 350*l.*; C. 140*l.*; D. 173,468*l.* 1*s.* 6¼*d.*; M. 175.

‡ *Wales East.* (*Cardiff*)—Cowbridge, Bridgend, Neath, Swansea, Llanelly, Merthyr, Brecon, Builth, Crickhowell, Abergavenny, Pontypool, Newport, Lantrissent, Caerphilly, and Cardiff. S. 350*l.*; C. 140*l.*; D. 82,329*l.* 0*s.* 10¾*d.*; M. 253.

§ *Wales Middle*, (*Welshpool*).—Bishop's Castle, Clunn, Knightou, Presteign, Hay, Kington, Radnor, Rhayader, Tregarron, Aberystwith, Llanyd-

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **WALES NORTH.*** | | | | | | | | | | | |
| **Caernarvon,** *Caernar.* 250 | 2 | 5 | 393 | 245 | 2 | 20 | 21 | 21 | 21 | | |
| **Conway,** (*North Wales*), *Carnarvon,* 263 - - | 2 | 7 | 425 | 144 | 4 | 7 | 9 | 12 | 12 | 16 | |
| **Denbigh,** *Denbighsh.* 218 | 2 | 5 | 390 | 145 | 3 | 6 | 8 | 8 | 20 | | |
| **Holywell,** *Flintshire,* 207 | 2 | 5 | 373 | 153 | 5 | 7 | 10 | 10 | 14 | | |
| **Llangefni,** *Anglesey.* 247 | | 7 | 369 | 118 | 8 | 10 | 12 | 14 | 16 | | |
| **WALES WEST.†** | | | | | | | | | | | |
| **Caermarthen,** *Caerm.* 232 | 2 | 6 | 416 | 168 | 7 | 10 | 10 | 13 | | | |
| **Haverfordwest,** *Pemb.* 251 | 2 | 6 | 414 | 254 | 1 | 7 | 8 | 13 | 17 | | |
| **Llandilo,** *Caermarth.* 202 | 1 | 8 | 614 | 537 | 6 | 7 | 12 | 12 | 12 | 12 | 12 |
| **Cardigan,** *Cardigan,* 233 | | 7 | 499 | 253 | 5 | 10 | 12 | 20 | 20 | | |
| **Pembroke,** *Pembroke,* 248 | 1 | 7 | 669 | 514 | 3 | 3 | 6 | 11 | 12 | 15 | 22 |
| **WELLINGTON.‡** | | | | | | | | | | | |
| **Bridgwater,** *Somerset,* 136 | 2 | 5 | 309 | 202 | 3 | 5 | 8 | 9 | | | |
| **Ilminster,** *Somerset,* 133 | 2 | 5 | 290 | 191 | 6 | 6 | 7 | 7 | 8 | 10 | |
| **Taunton,** *Somerset,* 144 - | 3 | 4 | 249 | 194 | 1 | 2 | 5 | 7 | | | |
| **Wellington,** *Somerset* 151 | 3 | 6 | 329 | 281 | 4 | 7 | 7 | 7 | 8 | 13 | 13 |
| **Yeovil,** *Somerset,* 122 - | 3 | 4 | 276 | 212 | 6 | 6 | 6 | 6 | 8 | 11 | |
| **WHITBY.§** | | | | | | | | | | | |
| **Bedale,** *Yorkshire,* 223 - | | 7 | 429 | 284 | 4 | 6 | 6 | 12 | 24 | 30 | |
| **Richmond,** *Yorks.* 235 - | 3 | 5 | 412 | 297 | 6 | 8 | 10 | 12 | 13 | 13 | |
| **Stockton,** *Durham,* 238 - | 3 | 5 | 359 | 208 | 2 | 5 | 6 | 11 | 13 | 14 | |
| **Thirsk,** *Yorkshire,* 217 - | 3 | 5 | 498 | 283 | 9 | 9 | 10 | 10 | 14 | 20 | |
| **Whitby,** *Yorks.* 244 - - | 1 | 5 | 430 | 172 | 5 | 11 | 21 | 27 | | | |
| **WIGAN.‖** | | | | | | | | | | | |
| **Bury,** *Lancashire,* 195 - | 1 | 7 | 379 | 313 | 3 | 4 | 4 | 5 | | | |
| **Bolton,** *Lancas.* 197 - | 3 | 4 | 223 | 208 | 2 | 2 | 4 | | | | |
| **Ormskirk,** *Lancas.* 220 - | 1 | 6 | 413 | 319 | 6 | 9 | 17 | 17 | 20 | | |
| **Wigan,** *Lancas.* 200 - | 1 | 6 | 401 | 262 | 8 | 8 | 5 | | | | |
| **Thattoheath,** *Lancas.* 198 | 4 | 2 | 165 | 41 | 2 | 2 | 3 | 3 | | | |
| **Parr,** *Lancashire,* 198 - | 2 | 2 | 128 | 35 | 2 | 5 | 5 | | | | |

---

loes, Newtown, Welshpool, Llanfyllin, Bala, Dolgelly, Machynleth, Llanfair, and Montgomery. S. 350*l.*; C. 140*l.*; D. 37,332*l.* 7*s.* 2*d.*; M. 323.

* *Wales, North, Carnarvon*) —Lanrwst, Corwen, Ruthin, Denbigh, Mold, Flint, Hollywell, St. Asaph, Abergele, Conway, Bangor, Pwllheli, Carnarvon, Holyhead, Llanerchymedd, Llangefni, and Beaumaris. S. 350*l.*; C. 140*l.*; D. 33,965*l.* 0*s.* 4¼*d.*; M. 230.

† *Wales, West,* (*Caermarthen*).—Narbeth, Tenby, Pembroke, Milford, Haverfordwest, St. David's, Fishguard, Newport, Cardigan, Newcastle, Lampeter, Llansawell, Llandovery, Llangadock, Llandilo, Caermarthen, Laugharne, and Kidwelly. S. 400*l.*; C. 140*l.*; D. 30,864*l.* 3*s.*; M. 239.

‡ *Wellington,* (*Taunton*) *Somersetshire.*—Stowey, Bridgewater, Milverton, Wiveliscombe, Uffculm, Cullumpton, Wellington, Langport, Somerton Ilchester, Sherborne, Yeovil, Petherton (South), Crewkerne, Chard, Ilminster, Lydeard, and Taunton. S. 350*l.*; C. 140*l.*; D. 63,584*l.* 19*s.* 5¾*d.*; M. 177.

§ *Whitby,* (*Thirsk*).—Masham, Middleham, Hawes, Askrigg, Leyburn, Bedale, Northallerton, Thirsk, Hovingham, Hemlsley, Kirby, Pickering, Egton, Guisborough, Stokesley, Yarm, Stockton, Darlington, Richmond, Reeth, Easingwold, and Whitby. S. 400*l.*; C. 140*l.*; D. 51,168*l.* 12*s*: 9¾*d.*; M. 315.

‖ *Wigan,* (*Bolton*).—Leigh, Wigan, Thattoheath collected at St. Helens;

| | D. | R. | Incl. | Excl. | From Residence. |
|---|---|---|---|---|---|
| WORCESTER.* | | | | | |
| Bromsgrove, *Worces.* 116 | 2 | 5 | 301 | 233 | 4 6 6 7 10 |
| Evesham, *Worcester*, 99 | 2 | 5 | 304 | 241 | 5 7 7 8 9 |
| Stratford-on-Avon, *Warwickshire*, 94 - - - | 3 | 5 | 275 | 218 | 8 8 8 10 12 |
| Worcester 1st, *Worc.* 111 | 5 | 2 | 151 | 117 | 8 8 |
| Ditto 2nd, - - - | 4 | 3 | 172 | 133 | 1 6 10 10 |
| YORK.† | | | | | |
| Knaresboro', *York*, 202 | 3 | 6 | 388 | 245 | 5 6 8 8 11 11 15 |
| Pontefract, *York*, 177 - | 3 | 5 | 187 | 181 | 4 4 4 5 5 5 |
| Snaith, *York*, 173 - - | 1 | 7 | 415 | 264 | 8 8 8 9 10 10 15 |
| Tadcaster, *York*, 186- - | 2 | 6 | 372 | 291 | 4 6 6 7 9 11 13 |
| York, *York*, 196 - - - | 4 | 3 | 241 | 129 | 6 8 |

## SCOTLAND.

| | D. | R. | Incl. | Excl. | From Residence. |
|---|---|---|---|---|---|
| ABERDEEN.‡ | | | | | |
| Aberdeen, 1st. *Aberd.* 528 | 7 | | 23 | 16 | 2 |
| Ditto, 2nd., - - - | 5 | 6 | 290 | 53 | 9 15 15 |
| Ditto, 3rd, - - - | 2 | 6 | 386 | 133 | 3 6 8 14 16 16 18 |
| Aboyne, *Aberdeen*, 558 - | | 7 | 760 | 178 | 5 5 11 18 19 21 |
| Old Meldrum, *Aberd.* 546 | 1 | 6 | 327 | 56 | 4 7 8 11 15 |
| Longside, *Aberdeen*, 560 | 3 | 7 | 378 | 239 | 1 6 7 7 10 13 15 [16 16 28 |
| AYR.§ | | | | | |
| Ayr, *Ayr*, 438 - - - | 2 | 5 | 410 | 154 | 9 12 16 22 |
| Greenock, *Renfrew*, 427 | 7 | 1 | 103 | 18 | |
| Paisley, *Ayr*, 413 - - | 8 | 1 | 125 | 60 | 4 4 |
| Kilmarnock, *Ayr*, 27 - | 4 | 4 | 295 | 159 | 3 5 7 14 15 |
| Rothesay, *Bute*, 453 - - | 1 | 6 | 815 | 14 | 14 32 32 42 42 |
| Dumbarton, *Dumb*, 420 | 3 | 5 | 221 | 24 | 4 8 8 13 13 |

---

Parr collected at St. Helens, and Prescot; Ormskirk, Chorley, Bury, (Lancashire,) and Bolton. S. 400*l.*; C. 140*l.*; D. 108,533*l.* 4*s.* 8*d.*; M. 112.

* *Worcester.*—Bromsgrove, Alvechurch, Droitwich, Upton, Alcester, Henley (in Arden), Stratford, Kineton, Bidford, Evesham, Pershore, and Worcester, S. 400*l.*; C. 140*l.*; D. 131,042*l.* 12*s.* 6¼*d.* M. 144.

† *York.*—Harewood, Wetherby, Aberford, Pontefract, Sherburn, Tadcaster, Knaresborough, Ripley, Patelybridge, Ripon, Boroughbridge-York, Howden, Goole, Thorne, Snaith, and Selby. S. 350*l.*; C. 140*l.*; D. 95,669*l.* 12*s.*; 10½*d.*; M. 205.

‡ *Aberdeen.*—Stonehaven, Kincardine O'Neil, Inverary, Oldmeldrum, Olddeer, Fraserburgh, Peterhead, Ellon, and Aberdeen. S. 400*l.* C. 140*l.* D. 87,457*l.* 2*s.* 8¾*d.* M. 191

§ *Ayr*, (*Greenock*).—Paisley, Port Glasgow, Rothesay, Dunoon, Dumbarton, Beith, Irvine, Ayr, Maybole, Mauchline, Kilmarnoch, and Greenock, S. 450*l.*; 1 C. 140*l.*; 1 C. £120; D.98,352*l.* 10*s.* 1¾*d.* M. 212.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **ARGYLE NORTH.**[*] | | | | | | | | | | |
| Port William, *Inv.* 546 | 1 | 4 | 857 | 123 | 2 | 10 | 40 | 41 | | |
| Long Island, (Stornoway) *Isle of Lewis* 534 - - | 1 | 5 | 747 | 6 | 34 | 60 | 90 | 136 | | |
| Mull, (Tobermory) *Isle of Mull*, 534 - - - | 1 | 5 | 764 | 1 | 17 | 28 | 30 | 40 | | |
| Oban, *Argyle*, 500 - - | 2 | 4 | 650 | 105 | 14 | 14 | 16 | 18 | | |
| Broadford, *Isle of Skye* 652 | 1 | 3 | 320 | 1 | 22 | 26 | 26 | | | |
| Poolewe, *Rossshire*, 648 - | | 4 | 878 | | 6 | 36 | 38 | | | |
| **ARGYLE SOUTH.**[†] | | | | | | | | | | |
| Campbeltown, 1st., *Cantire*, 490 - - - - - | 8 | 1 | 84 | 23 | 2 | | | | | |
| Ditto 2nd, - - - - - | 10 | 1 | 124 | 25 | | | | | | |
| Ditto 3rd, - - - - - | 8 | 1 | 169 | 21 | 2 | 10 | | | | |
| Inverary, Lochgilphead, *Argyleshire*, 458 - - | 1 | 5 | 734 | 49 | 7 | 9 | 15 | 24 | | |
| Newton, *Argylesh.*, 521 . | 4 | 3 | 242 | 25 | 2 | 3 | 6 | 6 | 8 | 18 |
| Port Ellen, *Argylesh.* 506 | 5 | 1 | 166 | 6 | 3 | 3 | 4 | 5 | | |
| **CAITHNESS.**[‡] | | | | | | | | | | |
| Orkney, *Kirkwall*, 756 - | 3 | 5 | 1129 | 13 | 16 | 16 | 16 | 16 | 30 | |
| Thurso, *Caith.* 720 - - | 4 | 2 | 460 | 29 | 2 | 4 | 7 | 8 | 48 | |
| Zetland, *Zetland*, 835 - | | 3 | 713 | | 6 | 40 | | | | |
| Wick, *Caith*, 698 - - | 2 | 3 | 782 | 30 | 12 | 15 | 19 | | | |
| Helmsdale, *Suther.* 662 | 1 | 3 | 527 | 1 | 12 | 28 | 36 | | | |
| **DUMFRIES.**[§] | | | | | | | | | | |
| Castle Douglas, *Kirk.* 352 | 1 | 4 | 469 | 170 | 8 | 12 | 15 | 15 | | |
| Dumfries, *Dumfries*, 336 | 2 | 5 | 507 | 218 | 3 | 8 | 13 | 15 | 27 | |
| Langholm, *Dumf.*, 391 - | 1 | 5 | 373 | 162 | 12 | 16 | 18 | 23 | | |
| Wigtown, *Wigtown*, 391 | 2 | 4 | 589 | 124 | 2 | 8 | 18 | 28 | 28 | |
| **EDINBURGH.**[‖] | | | | | | | | | | |
| Edinburgh 1st, *Edin.* 397 | 7 | | 30 | 21 | | | | | | |
| Ditto 2nd, - - - - - | 6 | | 23 | 17 | 1 | | | | | |
| Ditto 3rd, - - - - - | 5 | | 18 | 12 | | | | | | |
| Ditto 4th, - - - - - | 5 | 1 | 109 | 60 | 7 | 6 | 4 | | | |
| Leith, 1st, *Edinburgh*, 399 | 7 | | 25 | 21 | | | | | | |
| Ditto 2nd, - - - - - | 6 | | 45 | 35 | | 1 | 2 | | | |

---

[*] *Argyle, North*, (*Oban*).—Oban, Fort William, Tynribbie, Tobermory, Lochmaddy, Stornoway, Poolewe, collected at Loch Gairloch, Portree, and Broadford. S. 350*l.* C. 140*l.* D. 13,472*l.* 15*s.* 0¾*d.* M. 472

[†] *Argyle, South* (*Campbeltown*).—Bowmore, Port Ellen, Lochgilphead, and Campbeltown. S. 350*l.*; C. 140*l.*; D. 117,959*l.* 0*s.* 11¼*d.* M. 182.

[‡] *Caithness*, (*Thurso*).—Thurso, Wick, Stromness, Dunbeath, Helmsdale, Golsphic, Berridale, Kirkwall, and Lerwick. S. 350*l.*; C. 140*l.*; D. 21,113*l.* 9*s.* 6¾*d.*; M. 452.

[§] *Dumfries*—Hawick, Langholm,'Annan, Lockerby, Kirkudbright, Sanquhar, Thornhill, Castle Douglas, Gatehouse, Wigtown, Glenluce, Stranraer, Newton Stewart, and Dumfries. S. 350*l*; C. 140*l.*; D. 31,487*l.* 6*s.* 2¾*d.* M. 336.

[‖] *Edinburgh.*—Edinburgh. S. 600*l.* 1 C. 200*l.* 2 C. 150*l.* D. 496,858*l.* 1*s.* 4¾*d.*

| | D. | R. | Incl. | Excl. | From Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELGIN.* | | | | | | | | | | | |
| Banff, *Banff*, 573 | 5 | 7 | 597 | 112 | 2 | 8 | 8 | 8 | 14 | 14 | 14 |
| Grantown, *Morays.*, 632 | 2 | 5 | 493 | 90 | 5 | 5 | 14 | 21 | 21 | 28 | |
| Elgin, *Elgin*, 608 | 6 | 4 | 402 | 214 | 2 | 4 | 4 | 4 | 9 | 9 | 12 |
| Huntly, *Aberdeensh.*, 568 | 4 | 7 | 528 | 131 | 1 | 10 | 10 | 10 | 10 | 10 | 14 |
| Rothes, *Elginshire*, 620 | 3 | 4 | 167 | 71 | 2 | 4 | 4 | 8 | 10 | | |
| FIFE.† | | | | | | | | | | | |
| Dunfermline, *Fife*, 413 | 3 | 2 | 149 | 81 | 5 | 12 | 14 | | | | |
| Cupar, *Fife*, 444 | 4 | 5 | 270 | 161 | 6 | 8 | 10 | 10 | 10 | 10 | |
| Kirkcaldy, *Fife*, 410 | 5 | 3 | 170 | 97 | 1 | 1 | 7 | 8 | 10 | 10 | 18 |
| GLASGOW.‡ | | | | | | | | | | | |
| Glasgow 1st, *Lanark*, 405 | 6 | | 61 | 25 | 1 | 1 | 1 | 3 | 4 | | |
| Ditto 2nd, | 7 | | 29 | 15 | | | | | | | |
| Ditto 3rd, | 7 | | 66 | 29 | 1 | 1 | 1 | 1 | 2 | 2 | |
| Ditto 4th, | 11 | | 41 | 7 | | | | | | | |
| Ditto 5th, | 7 | | 13 | 11 | 2 | | | | | | |
| Ditto 6th, | 4 | 3 | 180 | 31 | 4 | 7 | 8 | | | | |
| Ditto 7th, | 6 | 1 | 112 | 73 | 1 | 1 | 3 | 6 | 10 | 11 | 11 |
| Ditto 8th, | 6 | | 16 | 13 | 1 | 1 | 1 | 1 | 2 | 2 | |
| HADDINGTON.§ | | | | | | | | | | | |
| Dalkeith, *Edinburgh.* 391 | 3 | 2 | 137 | 81 | 4 | 7 | 8 | | | | |
| Pennycuick, *Edinb.*, 400 | 1 | 4 | 180 | 75 | 3 | 8 | | | | | |
| Eyemouth, *Berwicks.* 349 | 1 | 4 | 252 | 102 | 9 | 9 | 15 | 25 | | | |
| Haddington, *Haddin.* 379 | 5 | 2 | 172 | 81 | 6 | 6 | 10 | 11 | 11 | | |
| Kelso, *Roxburgh*, 343 | 1 | 6 | 517 | 244 | 9 | 11 | 16 | 20 | | | |
| Musselburgh, *Edinb.* 390 | 7 | | 57 | 27 | 3 | 3 | 4 | 4 | | | |
| INVERNESS.‖ | | | | | | | | | | | |
| Drumnadrochit, *Inv.* 566 | | 7 | 692 | 19 | 14 | 15 | 16 | 16 | 16 | 21 | |
| Inverness, *Inverness*, 553 | 4 | 3 | 454 | 47 | 5 | 8 | 18 | 20 | | | |
| Tain, *Rossh.* 603 | 2 | 4 | 504 | 29 | 6 | 12 | 13 | 16 | 16 | | |
| Conanbridge, *Rossh.* 574 | 2 | 5 | 720 | 40 | 2 | 3 | 4 | 5 | 12 | 14 | |
| LINLITHGOW.¶ | | | | | | | | | | | |
| Falkirk, *Stirling*, 428 | 5 | 2 | 139 | 76 | 1 | 1 | 2 | 3 | 5 | 8 | |
| Hamilton, *Lanark*, 386 | 4 | 4 | 311 | 179 | 3 | 6 | 8 | 9 | 2 | 10 | 10 |
| Lanark, *Lanark*, 389 | 1 | 4 | 492 | 342 | 2 | 10 | 12 | 30 | | | |
| Linlithgow, *Linlith.* 415 | 4 | 2 | 169 | 108 | 7 | 7 | 11 | | | | |
| Queensferry, *Linlith.* 407 | 6 | | 76 | 44 | 3 | 7 | 10 | 10 | | | |

---

* *Elgin.*—Cullen, Banff, Foggielone, Huntley, Keith, Forres, Grantown, Dalnashaugh, Rothes, and Elgin. S. 350*l.* C. 140*l.* D. 68,782*l.* 16*s.* 0½*d.* M. 157.

† *Fife*, (*Kirkaldy.*)—Burntisland, Inverkeithing, Dunfermline, Kinross, Auchtermuchty, Cupar, (Fife,) St. Andrew's, Anstruther, Leven, and Kirkaldy. S. 450*l.*; C. 140*l.*; D. 130,056*l.* 5*s.* 4¾*d.* M. 98.

‡ *Glasgow.*—Glasgow. S. 450*l.*; 2 C. 140*l.*; D. 460,042*l.* 11*s.* 3¼*d.*

§ *Haddington, North.*—Berwick, Dunbar, Eyemouth, collected at Ayton, Dunse, and Coldstream; Kelso, Jedburgh, Selkirk, Melrose, Dalkeith, Pennycuick collected at Dalkeith, Musselburgh, Tranent, and Haddington. S. 350*l.*; C 140*l.*; D. 164,143, 11*s.* 2¼*d.* M. 190.

‖ *Inverness.*—Fortrose, Conanbridge, collected at Dingwall, Invergordon, Tain, Beauley, Drumnadrochit, Nairn, and Inverness. S. 350*l.* C. 140*l.*; D. 45,060*l.* 13*s.* 11¼*d.* M. 108.

¶ *Linlithgow*—Queensferry, Midcalder, Bathgate, Borrowstoness, Falkirk,

| | D. | R. | Incl. | Excl. | From Residence. |
|---|---|---|---|---|---|
| MONTROSE.* | | | | | |
| Blairgowrie, *Perthsh.* 453 | 3 | 4 | 543 | 73 | 5 6 10 15 16 20 |
| Dundee, *Forfarsh.* 450 | 4 | 2 | 155 | 87 | 4 9 |
| Forfar, *Forfarsh.* 474 | 1 | 6 | 619 | 146 | 6 8 10 15 15 18 |
| Montrose, *Forfarsh.* 488 | 6 | 3 | 307 | 97 | 8 8 9 13 13 13 |
| PERTH.† | | | | | |
| Aberfeldy, *Perthsh*, 462 | 2 | 6 | 405 | 173 | 4 4 4 6 10 13 23 |
| Crief, *Perth* 452 | 5 | 2 | 113 | 44 | 1 2 2 4 7 |
| Dunkeld, *Perth.* 454 | 2 | 5 | 130 | 74 | 6 7 7 7 11 |
| Perth, *Perth.* 440 | 4 | 3 | 226 | 122 | 1 5 9 12 |
| Pitlochry, *Perth.* 469 | 6 | 3 | 263 | 117 | 1 2 4 8 14 |
| Tullymet, *Perth.* 453 | 6 | 1 | 88 | 54 | 2 3 4 6 |
| STIRLING.‡ | | | | | |
| Stirling, *Stirling*, 433 | 8 | 1 | 96 | 55 | 2 2 3 4 7 |
| Alloa, 1st *Clackson*, 431 | 8 | | 46 | 41 | 3 4 3 |
| Ditto 2nd, | 6 | 1 | 116 | 49 | 3 5 5 6 10 |
| Kirkintilloch, *Dumb.* 413 | 6 | 1 | 135 | 17 | 2 3 3 5 6 |
| Kippen, *Stirling*, 442 | 4 | 5 | 337 | 51 | 3 6 6 8 12 12 18 |

## IRELAND.

**The distances of the Irish districts, except those at Dublin, are calculated in English miles *from Dublin*.**

| | D | R. | Incl. | Excl. | From Residence. |
|---|---|---|---|---|---|
| ARMAGH.§ | | | | | |
| Armagh, *Armagh*, 80 | 1 | 5 | 430 | 25 | 3 6 12 |
| Middletown, *Armagh*, 80 | 2 | 4 | 493 | 30 | 8 8 11 14 18 18 |
| Dungannon, *Tyrone*, 92 | 1 | 3 | 285 | 16 | |
| Lurgan, *Armagh*, 86 | 3 | 4 | 398 | 19 | 6 6 6 14 |
| ATHLONE.‖ | | | | | |
| Athlone, *Westmeath*, 76 | 2 | 4 | 362 | 10 | 13 13 |
| Castlerea, *Roscom.*, 108 | 1 | 4 | 435 | 9 | 5 8 19 |
| Carrick on Shannon, *Leitrim*, 98 | 1 | 4 | 521 | 2 | 10 12 26 |
| Longford, *Longford*, 82 | 1 | 4 | 437 | 6 | 6 15 23 |

---

Peebles, Biggar, Lanark, Strathaven, Hamilton, Airdrie, and Linlithgow. S. 450*l.* C. 140*l.* D. 135,469*l.* 4*s.* 11*d.* M. 197.

* *Montrose*, (*Dundee.*)—Arbroath, Bervie, Laurence Kirk, Brechin, Kertiemuir, Forfar, Dundee, Blairgowrie, Cupar (Angus), and Montrose. S. 350*l.* C 140*l.* D. 56,121*l.* 12*s.* 9½*d.* M. 195.

† *Perth.*—Auchterarder, Crieff, Dunkeld, Pitlochry, Weem, Tullymet collected at Logierart, Perth. S. 450*l.* C. 140*l.* D. 86,462*l* 8*s.* 9¾*d.* M. 157.

‡ *Stirling.*—Alloa, Kincardine, Denny, Downe, Kippen collected at Ladyland, Kirkintilloch, and Stirling. S. 450*l.* C. 140*l.* D. 221,263*l.* 1*s.* 9*d.* M. 124.

§ *Armagh*—Dungannon, Lurgan, Portadown, Middletown collected at Monaghan, Balligawly, Aughnacloy, Caledon, and Armagh. S. 450*l.*; C. 140*l.*; D. 60,754*l.* 17*s.* 5½*d.*. M. 121.

‖ *Athlone.*—Roscommon, Strokestown, Castlerea, Tobercorry, Ballyhadereen, Ballaghy, Boyle, Carrick-on-Shannon, Mohil, Granard, Castle Pollard, Longford, Ballymahon, and Athlone. S. 350*l.*; C. 140*l.*; D. 30,609*l.* 4*s.* 9¼*d.*; M. 209.

| | D. | R. | Incl. | Excl. | Fro m Residence. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CLONMEL.* | | | | | | | | | | | |
| Cashel, *Tipperary*, 97 - | 4 | 5 | 445 | 29 | 4 | 4 | 4 | 10 | 10 | 10 | 14 |
| Clonmel, *Tipper.* 109 - | 4 | 2 | 229 | 11 | 3 | 3 | 3 | 15 | | | |
| Cloughjordan, *Kings*, 88 | 2 | 4 | 198 | 31 | 10 | 11 | 11 | | | | |
| COLERAINE.† | | | | | | | | | | | |
| Ballymena, *Antrim*, 120 | 2 | 4 | 413 | 19 | 4 | 11 | 14 | 14 | | | |
| Ballyronan, *Derry*, 113 | 1 | 3 | 325 | 3 | 4 | 4 | 10 | | | | |
| Coleraine, *Derry*, 145 - | | 4 | 448 | 18 | 11 | 14 | | | | | |
| New Town Limavady, *Derry*, 136 - - - - | 3 | 2 | 368 | 17 | 9 | 9 | 14 | | | | |
| Ballymoney, *Antrim*, 137 | 2 | 3 | 311 | 6 | 1 | 1 | 16 | | | | |
| CORK.‡ | | | | | | | | | | | |
| Bandon, *Cork*, 175 - - | 2 | 4 | 443 | 36 | 12 | 18 | 20 | | | | |
| Cork 1st, *Cork*, 157 - - | 5 | | 33 | 12 | | | | | | | |
| Ditto 2nd, - - - - - | 1 | 4 | 61 | 27 | 5 | | | | | | |
| Ditto 3rd, - - - - - - | 2 | 2 | 203 | 28 | 7 | 7 | | | | | |
| Ditto 4th, - - - - - - | 3 | 1 | 163 | 14 | 15 | | | | | | |
| Skibbereen, *Cork*, 205 - | | 5 | 557 | 5 | 20 | 20 | 24 | 56 | | | |
| DROGHEDA.§ | | | | | | | | | | | |
| Belturbet, *Cavan*, 78 - | 1 | 6 | 528 | 44 | 10 | 10 | 10 | 20 | | | |
| Drogheda, *Louth*, 29 - | 3 | 5 | 530 | 20 | 8 | 10 | 17 | | | | |
| Navan, *Meath*, 30 - - | | 6 | 682 | 15 | 9 | 10 | 14 | 23 | | | |
| DUBLIN.‖ | | | | | | | | | | | |
| Dublin 1st, *Dublin*, 326 | 5 | | 34 | 12 | | | | | | | |
| Ditto 2nd, - - - - - - | 3 | 2 | 130 | 14 | | | | | | | |
| Ditto 3rd, - - - - - - | 5 | | 25 | 25 | | | | | | | |
| Ditto 4th, - - - - - - | 5 | | 19 | 19 | | | | | | | |
| Ditto 5th, - - - - - - | 6 | | 19 | 14 | | | | | | | |
| DUNDALK.¶ | | | | | | | | | | | |
| Carrickmacross, *Mon.* 54 | 2 | 5 | 527 | 50 | 8 | 14 | 14 | 14 | 14 | | |
| Dundalk, *Louth*, 51 - - | 3 | 3 | 275 | 47 | 10 | | | | | | |
| Newry, *Armagh*, 64 - | 3 | 4 | 535 | 270 | 7 | 11 | 15 | | | | |
| Clones, *Monaghan*, 78 - | | 5 | 823 | 3 | 8 | 14 | 18 | 18 | | | |

---

* *Clonmel.*—Cloughjordan, Nenah, Thurles, Cashel, Tipperary, Carrick-on-Suir, Fethard, and Clonmel. S. 400*l.*; C. 140*l.*; D. 80,205*l.* 17*s.* 4*d.* M. 180.

† *Coleraine.*—Dungiven, Newtown Limavady, Ballycastle, Bushmills Kilrea, Magherafelt, Antrim, Maghera, Cookstown, Ballyronan, Ballymena, Ballymoney, and Coleraine. S. 350*l.*; C. 140*l.*; D. 41,189*l.* 5*s.* 0½*d.*; M. 248.

‡ *Cork.*—Clonakilty, Skibbereen, Bantry, Dunmanway, Bandon, Kinsale, Macroom, and Cork. S. 450*l.*; 1 C. 140*l.*; 1 C. 120*l.*; D. 188,139*l.* 16*s.* 7¾*d.*; M. 189.

§ *Drogheda.*—Baileborough, Belturbet, Killesandra, Caven, Virginia, Kells, Athboy, Trim, Navan, Balbriggan, and Drogheda. S. 400*l.*; C. 140*l.* D. 76,023*l.* 15*s.* 5*d.*; M. 203.

‖ *Dublin.*—Dublin. S. 600*l.*; 1 C. 200*l.*; 1 C. 150*l.*; 1 C. 90*l.*; D. 353,734*l.* 18*s.* 9¼*d.*

¶ *Dundalk.*—Castle-Blaney, Ballybay, Clones, Cootehill, Carrickmacross, Kingscourt, Ardee, Warrenspoint, Newry, and Dundalk. S. 450*l.*; C. 140*l.* D. 102,638*l.* 6*s.* 8½*d.* M. 150.

| | D. | R. | Incl. | Excl. | From Residence. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FOXFORD.[*] | | | | | | | | | | |
| Ballinrobe, *Mayo*, 143 - | 1 | 4 | 367 | 13 | 0 | 16 | 23 | 26 | | |
| Ballina, *Mayo*, 154 - - | 2 | 2 | 325 | 8 | 11 | 11 | | | | |
| Wesport, *Mayo*, 155 - - | 1 | 2 | 321 | 7 | 9 | | | | | |
| GALWAY.[†] | | | | | | | | | | |
| Galway 1st, *Galway*, 131 | 3 | | 13 | 0 | | | | | | |
| Ditto, 2nd, - - - - | 1 | 2 | 191 | 13 | 2 | 5 | 6 | | | |
| Loughrea, *Galway*, 109 - | 1 | 4 | 559 | 21 | 18 | 18 | 18 | 20 | | |
| KILKENNY.[‡] | | | | | | | | | | |
| Carlow, *Carlow*, 49 - - | 3 | 2 | 234 | 30 | 12 | | | | | |
| Kilkenny, *Kilkenny*, 73 | 5 | 1 | 134 | 13 | 4 | 5 | 10 | | | |
| Leighlin Bridge, *Car.* 57 | | 6 | 451 | 17 | 3 | 13 | 28 | 36 | | |
| Mountmellick, *Queen's County*, 53 - - - | | 6 | 293 | 51 | 7 | 7 | 8 | 12 | | |
| LIMERICK.[§] | | | | | | | | | | |
| Kilrush, *Clare*, 177 - - | 2 | 2 | 348 | 19 | 27 | 28 | | | | |
| Limerick, *Limerick*, 120 | 3 | 3 | 294 | 31 | 5 | 10 | 15 | | | |
| LISBURN.[‖] | | | | | | | | | | |
| Belfast 1st, *Antrim*, 102 | 6 | | 38 | 25 | | | | | | |
| Ditto 2nd, - - - - | 3 | 3 | 14 | 19 | 2 | 2 | 2 | | | |
| Carrickfergus, *Antrim* 110 | 1 | 4 | 426 | 18 | 11 | 11 | 12 | | | |
| Comber, *Down*, - - - | 2 | 4 | 421 | 10 | 4 | 8 | | | | |
| Downpatrick, *Down*, 94 | 3 | 5 | 353 | 12 | 2 | 2 | 9 | 9 | 9 | 9 |
| Hillsborough, *Down*, 88 - | 1 | 6 | 563 | 20 | 4 | 4 | 13 | | | |
| LONDONDERRY.[¶] | | | | | | | | | | |
| Burt, *Donegal*, 152 - - | 2 | 4 | 573 | 6 | 3 | 7 | 16 | 30 | 27 | |
| Londonderry, *Derry*, 143 | 5 | 1 | 79 | 24 | | | | | | |
| Omagh, *Tyrone*, 111 - | 1 | 4 | 448 | 12 | 10 | 10 | 18 | | | |
| Ramelton, *Donegal*, 149 | | 5 | 599 | 13 | 5 | 9 | 20 | 48 | | |
| Strabane, *Tyrone*, 130 - | 1 | 5 | 537 | 15 | 4 | 8 | 9 | 15 | | |

---

[*] *Foxford*, (*Castlebar.*)—Clare, Bellendine, Dromore, Tuam, Headfort, Shrule, Ballinrobe, Ballina, Easkey, Killala, Ballycastle, Bingham's Town, Crossmolina, Foxford, Swinford, Keltinghaugh, Balla, Westport, Newport, and Castlebar. S. 350*l.*; C. 140*l.*; 26,788*l.* 3*s.* 1¼*d.* M. 312 or 136.

[†] *Galway.*—Ballinasloe, Loughrea, Gort, Oranmore, Clifden and Galway. S. 350*l.*; C. 140*l.*; 42,869*l.* 1*s.* 8¼*d.*; M. 232.

[‡] *Kilkenny.*—Leighlinbridge, Tullow, Carlow, Castlecomer, Mount Mellick, Maryborough, Mountrath, Durrow, Callan, and Kilkenny. S. 350*l.*; C. 140*l.*; D. 72,266*l.* 8*s.* 10¾*d.* M. 166.

[§] *Limerick.*—Eunis, Kilrush, and Limerick. S. 450*l.*; C. 140*l.*; D. 71,507*l.* 15*s.* 5¼*d.*; M. 190.

[‖] *Lisburn*, (*Belfast*).—Hillsboro', Bunbridge, Lisburn, Larne, Carrickfergus, Castlewellan, Downpatrick, Comber collected at Saintsfield and Newtown Ardes; and Belfast. S. 450*l.*; C. 140*l.*; D. 181,175*l.* 4*s.*; M. 170.

[¶] *Londonderry*—Strabane, Omagh, Newtown-Stewart, Gortin, Castlederg, Stranorlar, Raphoe, Lestterkenny, Ramelton, Newtown Cunningham, Boneyfoble, Carn, Bunerana, and Londonderry. S. 400*l.*; C. 140*l.*; D. 73,112*l.* 14*s.* 11¼*d.*; M. 214.

| | D. | R. | Incl. | Excl. | From Residence. |
|---|---|---|---|---|---|
| MALLOW.[*] | | | | | |
| Fermoy, *Cork*, 136 - - | 1 | 3 | 327 | 23 | 11 12 20 |
| Mallow, C*ork*, 150- - - | | 4 | 445 | 2 | 14 16 22 |
| Middleton, *Cork*, 155 - | 3 | 2 | 218 | 23 | 2 16 |
| MARYBOROUGH.[†] | | | | | |
| Birr, *King's County*, 61 | 4 | 1 | 144 | 13 | 9 9 |
| Kilbeggan, *Westm.* 56 | 1 | 4 | 375 | 11 | 11 15 19 |
| Roscrea, *Tipperary*, 75 | 2 | 3 | 282 | 54 | 2 7 13 16 |
| Tullamore, *King's C.* 59 | 2 | 2 | 185 | 10 | 14 |
| NAAS.[‡] | | | | | |
| Bray, *Wicklow*, 12 - - | 1 | 3 | 272 | 34 | 10 10 20 |
| Leixlip, *Kildare*, 10 - - | 2 | 4 | 632 | 19 | 9 9 18 25 |
| Monasterevan, *Kildare* 38 | 1 | 4 | 455 | 29 | 2 15 27 |
| Rathfarnham, *Dublin*, 4 | 4 | 1 | 133 | 22 | 13 6 8 14 |
| SLIGO.[§] | | | | | |
| Ballyshannon, *Don.* 129 | 1 | 4 | 355 | 10 | 15 29 33 |
| Enniskillen, *Ferm.* 101 | 2 | 3 | 473 | 12 | 11 12 |
| Sligo, *Sligo*, 132 - - | 1 | 3 | 399 | 6 | 5 15 |
| TRALEE.[‖] | | | | | |
| Newcastle, *Limerick*, 145 | | 4 | 541 | 6 | 8 28 36 |
| Tralee, *Kerry*, 184 - - | 1 | 4 | 609 | 15 | 15 23 33 |
| WATERFORD.[¶] | | | | | |
| Dungarvon, *Waterf.* 118 | 1 | 3 | 324 | 5 | 16 16 22 |
| New Ross, *Wexford*, 86 | 2 | 6 | 515 | 44 | 13 14 16 20 |
| Waterford, *Waterf.* 95 - | 4 | 2 | 239 | 29 | |
| WEXFORD.[**] | | | | | |
| Carnew, *Wicklow*, 56 - | | 6 | 585 | 22 | 10 10 12 20 23 |
| Enniscorthy. *Wexf.* 76 - | 3 | 3 | 377 | 14 | 12 16 |
| Wexford, *Wexf.* 92 - - | 6 | 2 | 156 | 24 | 7 |

---

[*] ***Mallow***, (*Fermoy*).—Kanturk, Charleville, Mallow, Mitchelstown, Clogheen, Kilmallock, Youghall, Middleton, Rathcormac, and Fermoy. S. 350*l.*; C. 140*l.*; D. 87,860*l.* 5*s.* 6*d.*; M. 195.

[†] ***Maryborough***, (*Birr*).—Mullingar, Kilbeggan, Tullamore, Templemore, Roscrea, and Birr. S. 350*l.*; C. 148*l.*; D. 70,747*l.* 5*s.* 5¼*d.*; M. 72.

[‡] *Naas*, (*Peter Place, near Dublin*).—Leixlip, collected at Maynooth, Kilcullen, and Naas; Rathfarnham, collected at Peter Place; Athy, Monasterevan, Edenderry, Bray, and Wicklow. S. 400*l.*; C. 140*l.*; D. 51,476*l.* 18*s.* M. 228.

[§] *Sligo.*—Ballyshannon, Donegal, Pettigo, Kish, Lowthertown, Enniskillen, Mannorhamilton, Fintona, Coolaney, Ballymote, Coloony, Drumkerin, Dromahaire, and Sligo. S. 400*l.*; C. 140*l.*; D. 44,644*l.* 8*s.* 7¾*d.* M. 172.

[‖] *Tralee.*—Listowell, Rathkeal, Newcastle, Killarney, Limerick, Dingle, and Tralee. S. 350*l.*; C. 140*l.*; D. 11,411*l.* 7*s.* 1¾*d.*; M. 252.

[¶] *Waterford.*—Dungarvan, Lismore, Thomastown, Graigue, New Ross, and Waterford. S. 400*l.*; C. 140*l.*: D. 66,032*l.* 16*s.* 3¾*d.* M. 149

[**] *Wexford.*—Enniscorthy, Newtown-barry, Gorey, Arklow, and Wexford. S. 350*l.*; C. 140*l.*; D. 78,037*l.* 0*s.* 1¾*d.*; M. 106.

### 10. *Of the London Establishment.*

The London collection or Establishment, which includes the district within the limits of the chief office, is placed on a different footing from the country collections, in consequence of this contiguity, and also of the magnitude of its operations. It comprises the cities of London and Westminster; the borough of Southwark and its suburbs; the Parishes within the bills of mortality; together with St. Marylebone, and St. Pancras. One of the class of officers, called Surveying General Examiners, is at the head of the London collection; the duties of Collector being performed by *seven General Surveyors*, each of whom has the superintendence of a certain portion of the Metropolis, called a general survey; which is again subdivided into 33 districts, each of which is under the management of a *Surveyor*; and each district is subdivided into divisions, which are in charge of *Principal Officers*, or *Surveying Officers* as the case may be.

The salaries of the officers forming the surveying branch of the Town Establishment are as follows:—General Surveyor, £250; Surveyor £150; Examiner, £115, with an addition of 2s. per diem when acting for a surveyor; Principal Officer, £115; Officer, £100. In other respects, the salaries and course of promotion are nearly the same as in the Country Surveying Department.[*]

---

[*] The following appointments with some exceptions, may be considered as forming part of the London Establishment, although not included in the Surveying Department. The salaries, &c., are extracted chiefly from the Twentieth Report on the Excise Enquiry; but it is understood that several alterations have been made since the date of that Report, and that others are in contemplation.

*Appointments by Patent.*

Commissioners, (see p. 248.) Deputy Comptroller General (£600.)

*Appointments by the Treasury.*

Solicitor, (£2,500); Assistant Solicitor, (£1,000); Solicitor in Scotland, (£1,500); Solicitor in Ireland, (1,500); Four Commissioners of Appeal, (£165 each); Register, (£97 10s.); Comptroller of Cash, (£600 10s.), Auditor, (£800).

*Appointments by the Board at the Nomination of the Treasury.*

Secretary, (£1,500); Under Secretary (£850); Assistant Secretary (£550); Receiver General, (£1,500); Clerk of the Securities, (£600).

*Appointments by the Board at the Nomination of the Treasury, or by the Commissioners.*

*Secretary's Department*—1st Branch, 5 Clerks, (£250 to £400); 2d Branch, 11 Clerks, (£100 to £250); *Solicitor's Department*—10 Clerks, (£90 to £400); Messenger, (£60); *Solicitor's Department in Scotland*—4 Clerks, (£100 to £350); *Solicitor's Department in Ireland*—5 Clerks (£100 to £350); *Receiver-General's Department*—7 Clerks (£90 to £500); 3 Receivers, (£160 to £280); Billman (£70); *Accountant's Department*—1st General Accountant (£600); 5 General Accountants, (£310 to £500); 42 Accountants, (£80 to £250);

### 11. *Of the Order of Promotion.*

The Board of Excise recognizes as one of its most important responsibilities the duty of keeping the service in a state of efficiency. To attain this object, a systematic examination is made of the performances and proceedings of each established officer before he can be advanced in rank; and the duties of the various classes of officers are allotted to each in such a manner, as to render those officers a constant check upon each other. The collector is a check upon the supervisor, the supervisor upon the officer; and the vigilance and uncertain visits of the Surveying General Examiners, (which are not permanent, but directed, without any previous intimation, on a given point,) are intended to hold a perpetual check over the whole of the surveying department: and to render the system still more perfect, an officer is not promoted unless (having served the time required in one grade,) he petitions for advancement to another; but having petitioned, his performances are subjected to a rigid examination, in order to ascertain what his conduct has been in the discharge of his duty. This is technically termed examining or "taking out his character," which is laid in detail before the Board for approval or otherwise, as the same shall appear to deserve.

The diaries of the Supervisors shewing their daily performances, and the neglects and irregularites they discover on the examination of the officers' books, with the Collectors' observations thereon, as before stated, are transmitted by the collectors every round; and after being registered in the diary office, are laid before the Commissioners; who, order such consures upon any officers' com-

---

*Accountant's Department, Scotland*—General Accountant (£450); 10 Accountants, (£80 to £250); *Accountant's Department, Ireland*—General Accountant (£450); 12 Accountants, (£80 to £250); *Security Department*—7 Assistants, (£90 to £300); *Store Department*—Store-Keeper, (£300); 5 Clerks, (£80 to £180); 4 Porters, (£70 to £80); *Warehouse-Keeper's Department*—Warehouse-Keeper, (£136 10s.); 2 Assistants (£78 to £80); *Housekeeper's Department*—Housekeeper, (£200); Porter, (£50) Yard-keeper, (£50); 9 Watchman, (£50 each); 8 Fire-lighters, (£60 each); *Export Department*— Surveyor, (£291 10s.); 2 Assistant Export Surveyors, (£151 5s. each); *Port Establishment*—Port Surveyor, (£231 5s. 0d.); Various Import Officers and Export Officers, (£90 to 100); *Miscellaneous Departments;*—Registrar, (£200); Registrar's Clerk, (£110); Inspector of Printing, (£90); 3 Doorkeepers, (£100 each); Messengers, (£78 10s. each); Book-Sorter and Assistant (£80 each); Various Permit Writers, Warehouse-keepers, Preventive Officers and Revenue Police.

The first appointments in the foregoing respective departments, are usually to the junior situations; the promotions being regulated by the Board.

The Comptroller General and Auditor, have had the appointment of their own Clerks.

plained against as their conduct appears to require; and such censures are recorded in the Diary Office, to which reference is made when an officer petitions for promotion, before his petition is recorded. An officer's books are examined for one quarter of a year only, but a supervisor's performances are examined for a year, and the books of all the officers under him for a quarter of a year. The examination consists in seeing that the parties have kept their books and entered their accounts therein, in the prescribed form, and surveyed the traders under their care with diligence and circumspection; and that the gauges and accounts are correctly cast and made up; and if any errors, or omissions of moment are discovered therein, the Supervisor is responsible as well as the officers. This examination is made by the Examiners who record every complaint they discover, ; and when the examination of any set of books is completed, the investigation is taken up by a Surveying General Examiner, who carefully compares aud examines the truth and correctness of every complaint, and makes out the candidate's character for laying before the Board, to whom it is read by one of the Secretaries; and the decision is said to be made without the name of the party being known to the Commissioners.*

---

* By a General Order made since the foregoing pages were in the press (April 30, 1840,) every person seeking promotion in the surveying branch of the Excise, is required to possess a knowledge of Book-keeping by double entry. Should any particular system be adopted, the officers will doubtless be furnished with precedents. In the meantime, the following brief statement may be found useful.

BOOK-KEEPING is the method of keeping Commercial accounts in such a manner, that a person may thereby know at any time, the true state of his affairs with clearness and expedition.

Book-keeping by SINGLE ENTRY requires two principal kinds of books; a Day Book and Ledger. The *Day Book* begins with a list of debts due to and from the owner; then every transaction by which new debts are contracted, or former debts discharged, is entered as it occurs; with the quantities, prices of goods bought or sold, or other circumstances necessary for explaining the transaction. These transactions are subsequently posted into the *Ledger*, which contains an account for every person with whom there are dealings on credit; the articles for which he is accountable to the owner, and those for which the owner is accountable to him, being placed in opposite pages of the same folio; the Dr. articles on the left hand pages, and the Cr articles on the right hand pages.

Book-keeping by DOUBLE ENTRY requires three principal Books, viz., the Waste Book, the Journal, and the Ledger. In the *Waste Book*, the Merchant's dealings are recorded without any particular order, beginning with a list of debts and property, and carried on with a full relation of each transaction, similar to the entries in the Day Book by single entry. In the *Journal* the contents of the Waste Book are separated every month, and entered on the Debtor and Creditor sides—all money and articles received, and all those who receive money or goods, being made debtors to cash or to the goods. In the *Ledger*, the posts entered in the Journal

In the examination of a Supervisor's character the number and kind of traders he has surveyed, daily, in each of the stations in his district are abstracted from the survey books, and compared with the number and kind he has accounted for in his diary, and also the number and kind of charges and gauges he has taken and accounted for therein: and it is likewise noticed whether his time on survey has been judiciously employed;—whether he has been too long employed on any duty which ought to have occupied a shorter period;—whether he has paid due attention to the more important traders and duties under his care, without neglecting any of the rest;—whether he has on any occasion spent more time than was necessary in the performance of his in-door work, or performed the same at improper times;—whether he has neglected visiting remote officers and traders by surveying more frequently those situate in and near to his residence;—and whether he has slept more frequently in his residence than he ought to have done consistently with his duty as a check officer.

By a recent General Order, a Supervisor is not eligible for promotion, unless he shall have surveyed for a year, in a business wherein a *Distillery* is situate.

All persons in the Excise are strictly prohibited from applying to any Members of Parliament or private Gentlemen to procure promotion for them; and are only allowed to apply for it by their own letter to the Board, or to an individual Commissioner.

### 12. *Of the Privileges of Excise Officers.*

Excise Officers are exempted from taking parish apprentices, 4 & 5 W. 4. c. 51, s. 3, and from serving in the militia, or on any jury, or in any corporate or parochial or public office, 7 & 8 G. 4, c. 53, s. 11; but these privileges do not extend (as has been erroneously supposed,) to an exemption from paying highway rates.

No action can be brought against an officer for any act done in the performance of his duty without a month's previous notice in writing, 7 & 8 G. 4, c. 53, s. 114.

---

are placed under particular accounts, and from these, every year the balance is drawn.

It will thus be seen that by single entry, the posts of Debtor and Creditor are separated from each other, and entered in such a way that each one appears singly; while in double entry Creditor and Debtor are in continual mutual connection; to which end all the posts are entered doubly, once on the debtor, and once on the creditor side; and thus every error or mistake is prevented.—*Conversations—Lexicon.*

### 13. *Of Superannuation Deductions and Allowances.*

Under the Superannuation Act, 4 and 5 W. 4, c. 24, s. 27, abatement is made from the salaries of all persons who have tak office in the Excise since 4th of August, 1829, as follows:—Fr salaries and emoluments not exceeding the annual sum of £10 an abatement after the rate of £2 10s. per cent.; and from salari and emoluments exceeding £100, £5 per cent.

The conditions on which the superannuation allowances ar granted, are as follows:—No superannuation allowance is grante to any officer or clerk under 65 years of age, unless upon certificat from the heads of the department to which such officer or clerk belongs, and from two medical practitioners, that he is incapable, fro infirmity of mind or body, to discharge the duties of his situation; nor unless he shall have discharged those duties with diligence and fidelity to the satisfaction of the head officer or officers of his department; which is to be certified by any two of such head officers, if there shall be more than one, or by such head officer, if there shall be but one; s. 11. And the superannuation is not to be granted on any advanced amount of salary received for less than three years, s. 12.

The amount of superannuation is not to exceed the following proportion, with reference to the officer's salary, and period of service, respectively; s. 9, 10.*

| If the officer entered the service before the 5th Aug. 1829.† | |
|---|---|
| Years of Service. | Proportion of Salary, &c. |
| 10 and under 15 | $\frac{4}{12}$ |
| 15 and under 20 | $\frac{5}{12}$ |
| 20 and under 25 | $\frac{6}{12}$ |
| 25 and under 30 | $\frac{7}{12}$ |
| 30 and under 35 | $\frac{8}{12}$ |
| 35 and under 40 | $\frac{9}{12}$ |
| 40 and under 45 | $\frac{10}{12}$ |
| 45 and under 50 | $\frac{11}{12}$ |
| 50 and upwards. | $\frac{12}{12}$ |

| If the officer entered the service after the 5th Aug. 1829. | |
|---|---|
| Years of Service. | Proportion of Salary, &c. |
| 10 and under 17 | $\frac{3}{12}$ |
| 17 and under 24 | $\frac{4}{12}$ |
| 24 and under 31 | $\frac{5}{12}$ |
| 31 and under 38 | $\frac{6}{12}$ |
| 38 and under 45 | $\frac{7}{12}$ |
| 45 and upwards. | $\frac{8}{12}$ |

And none to exceed this amount except under special circumstances to be ordered by the treasury. 4 and 5 Wil. 4, c. 24, s. 17.

---

* In ordinary cases, a deduction is made from the proportions stated of about one-tenth of the respective amounts.

† These allowances are the same as were granted by 3 G. 4, c. 113, s. 1

NCI

ARTIC ENCI

AUCTIONS - Estates, &c. - ......
Goods and Chattels leginn
Sheep's Wool - ge on t
Foreign Produce (if no arrels,
BRICKS - - Common - - 500 b
Large - - - - £47 5
GLASS - - - Plate { Materials or ule by,
Ground and 1 ......
Publi
Flint { Fluxed Mate ......
Excess on di annum
Crown German, Sheet er 4 8
Crown in Rectangular Premis
German Sheet or Bro runk
gular Panes - ......
Common Bottles - RS ..
HOPS - - - Cured and made fit fo each g
ers....
MALT - - - From Barley - - e on q
From Bear or Bigg quart
Upon Beer exported ls. 6d.
Upon Proof Spirits { quarte
Malt only - s. 7½d
PAPER - - - Paper, Millboard, Pas
Paper used by Cloth ......
Presses - - ......
Paper used in Printing ......
sities - - Great I
Books and Periodicals ......
Stained Paper - RS or
POST HORSES, Let by the Mile Reta
Less than Eight Mile Scotlan
the sum charged, Ireland
Ditto not bringing bac se pre
Let by the day, &c., o r ann
sum charged, or a r ann
r ann
Not exceeding three r ann
Exceeding three and r ann
Exceeding thirteen a r ann
SOAP - - Hard - - - - wards.
Soft - - - - und, re
Soap used in the Manufacture of { Cloths ......
lens r ann
Flax or r ann
Linen r ann
SPIRITS - - Distilled in the United r ann
SUGAR - - Made in the United K wards,
VINEGAR - Made in the United K RS ....
*COUNTERVAILI* CTUR
on
MIXTURES, Ether - - - ......
&c. Certain Spirits, Tin 00 lbs.
nishes, &c. - 6 5s.;
Other Tinctures, and m cco an
Sweets, or made Wine
ot hav
beer
*All the ab* beer n
The sum retail

ES.
2

| ES. | For a whole Year. | ¾ of a Year. | ½ a Year. | ¼ of a Year. |
|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| | 5 5 0 | 3 18 9 | 2 12 6 | 1 6 3 |
| ers | 0 10 6 | | | |

he quantity brewed, viz:—Not exceeding 20 barrels 10s. 6d.; 50 barrels £1 11s. 6d.; 1,000 barrels, £2 2s.; 2,000 barrels, £3 3s.; 5,000 barrels, arrels, £11 16s. 3d.; 10,000 barrels, £15 15s.; 20,000 barrels, £31 10s.; s.; 40,000 barrels, £63; exceeding 40,000 barrels £78 15s.

| | | | | |
|---|---|---|---|---|
| retail. | 5 10 3 | 4 2 8¼ | 2 15 1½ | 1 7 6¾ |
| | 3 6 1¾ | 2 9 7¼ | 1 13 0¾ | 0 16 6¼ |
| ans) rated under £20 | | | | |
| | 1 2 0½ | 0 16 6¼ | 0 11 0¼ | 0 5 6 |
| | 3 6 1¾ | 2 9 7¼ | 1 13 0¾ | 0 16 6¼ |
| 5 W. 4, c. 85, to be | | | | |
| es | 3 6 1¾ | | | |
| on the premises | 1 2 0½ | | | |
| | 1 2 0½ | | | |
| | 0 11 6½ | 0 8 7¾ | 0 5 9¼ | 0 2 10½ |
| lass house | 21 0 0 | 15 15 0 | 10 10 0 | 5 5 0 |
| | 0 7 10½ | | | |

uantity made, viz:—
ers, 7s. 10½d.; 100 quarters, 15s. 9d.; 150 quarters, £1 3s. 7½d.; 200 ; 250 quarters, £1 19s. 4½d.; 300 quarters, £2 7s. 3d.; 350 quarters, £2 rs, £3 3s.; 450 quarters, £3 10s. 10½d.; 500 quarters, £3 18s. 9d.; 550 .; exceeding 550 quarters £4 14s. 6d.

| | | | | |
|---|---|---|---|---|
| | 0 2 7½ | | | |
| | 4 4 0 | 3 3 0 | 2 2 0 | 1 1 0 |
| | 1 1 0 | | | |
| Britain | 0 7 6 | | | |
| | 4 4 0 | 3 3 0 | 2 2 0 | 1 1 0 |
| RECTIFIERS | 10 10 0 | 7 17 6 | 5 5 0 | 2 12 6 |
| ilers | 10 10 0 | 7 17 6 | 5 5 0 | 2 12 6 |
| d or Ireland | 0 10 6 | 0 7 10½ | 0 5 3 | 0 2 7½ |
| or Scotland | 0 10 6 | 0 7 10½ | 0 5 3 | 0 2 7½ |
| mises are rated | | | | |
| m | 2 4 1 | 1 13 0¾ | 1 2 0½ | 0 11 0¼ |
| m | 4 8 2¼ | 3 6 1¾ | 2 4 1 | 1 2 0½ |
| m | 6 12 3½ | 4 19 2½ | 3 6 1¾ | 1 13 0¾ |
| m | 7 14 4 | 5 15 9 | 3 17 2 | 1 18 7 |
| m | 8 16 4¾ | 6 12 3½ | 4 8 2¼ | 2 4 1 |
| m | 9 18 5¼ | 7 8 10 | 4 19 2½ | 2 9 7¼ |
| | 11 0 6 | 8 5 4½ | 5 10 3 | 2 15 1½ |
| tailing spirits whose | | | | |
| m | 9 18 5¼ | 7 8 10 | 4 19 2½ | 2 9 7¼ |
| m | 11 0 6 | 8 5 4½ | 5 10 3 | 2 15 1½ |
| m | 12 2 6½ | 9 1 10¾ | 6 1 3¼ | 3 0 7½ |
| m | 13 4 7 | 9 18 5¼ | 6 12 3½ | 3 6 1¾ |
| | 14 6 7¾ | 10 14 11¾ | 7 3 3¾ | 3 11 7¾ |
| | 1 2 0½ | 0 16 6½ | 0 11 0¼ | 0 5 6¼ |
| ERS Beginners | 5 5 0 | | | |
| the quantity made | | | | |

., £5 5s.; 40,000 lbs., £10 10s.; 60,000 lbs., £15 15s.; 80,000 lbs, £21. exceeding 100,000 lbs., £31 10s.

| | | | | |
|---|---|---|---|---|
| d Snuff | 0 5 3 | 0 3 11¼ | 0 2 7½ | 0 1 3¾ |
| | 5 5 0 | 3 18 9 | 2 12 6 | 1 6 3 |
| ing licences for re- | | | | |
| | 10 10 0 | 7 17 6 | 5 5 0 | 2 12 6 |
| t spirits | 4 8 2¼ | 3 6 1¾ | 2 4 1 | 1 2 0½ |
| beer and spirits | 2 4 1 | 1 13 0¾ | 1 2 0½ | 0 11 0¼ |

# CHAPTER II.

# EXCISE DUTIES.

UNDER this head it is proposed to insert an account of the present Excise Duties, Drawbacks and Allowances, arranged in alphabetical order, with descriptions of the principal trades under the survey of the Excise Officers, and the regulations for charging the duties; but in order to avoid repetition, it will be proper, in the first place, to advert to the origin and classification of the Excise duties; and to insert some general regulations applicable to various kinds of trades, and which cannot be conveniently classed in the alphabetical arrangement.

## PART I. GENERAL REGULATIONS, &c.

### 1. *Of the Origin, &c. of the Excise Duties.*

Customs' duties are one of the most ancient modes of obtaining a public revenue known but Excise duties were not levied in England before the year 1643,* when the long parliament proposed on the 16th of May, that an excise should be laid, as follows: "For each barrel of strong beer or ale, of 8s. the barrel, 1s.; for a hogshead of cyder or perry, 1s.; to be paid by the first buyer. The same tax was laid on the housekeeper for beer, ale, cyder, or perry brewed or made for his own spending. All alehouse-keepers or inn-holders that brew and sell strong ale and beer of their own, each barrel, 2s. For all sorts of retailed wines, over and above the customs due for the same, to be paid by first retailers, a quart, 2d. On all sorts of wines bought here, besides customs, to be paid by the first buyer, for all he should use in his own house, for a quart, 1d. The same to be paid by the merchant, for all the wine he shall use in his own house, besides the due customs. For a barrel of 6s beer sold, to be spent, as well in private as in victualling houses to be paid by the common brewer, or those that brew or sell the same beer, 6d. On all tobacco not of English plantation, the pound value, not weight, 4s. For the English plantation, the same value, both over and above all other customs, 2s."

---

* *Cobbett's Parliamentary History, vol.* III. *p.* 114. The first attempt to introduce the Excise, was made in 1626 by a Commission under the Great Seal, but Parliament having remonstrated against the measure the Commisssion was cancelled; and when the duty was imposed during the civil war it was continued only from month to month, and was collected with the greatest difficulty.—*Commissioners' Report.*

The excise, although a deviation from the former system of taxation, and resorted to as a temporary mode of supplying the wants of the country, was found too productive a source of revenue to be again relinquished; and when the nation had been accustomed to it a few years, the parliament declared in 1649, that "the impost of excise was the most easy and indifferent levy that could be laid upon the people." This declaration ill agrees with Sir William Blackstone's statement, "that from its first origin to the present time, the very name of the excise has been odious to the People of England;" and also with Marvell's description, quoted by Dr. Johnson, "that the excise is a hateful tax levied upon commodities, and adjudged not by the common judges of property." There is no doubt that the imposition of the excise duty was, in the first instance, unpopular, but after its first introduction it continued to gain ground until nearly one half of the national revenue was furnished by it.

The act which is usually considered as the foundation of the present excise laws is 12 Car. 2, c. 24, which granted from Christmas 1660, certain rates of excise upon beer, ale, cider, perry, metheglin or mead, vinegar-beer, strong water, acqua vitæ, beer and cyder, imported spirits made from wine or cyder imported, and strong water perfectly made and imported; and it obliged all common brewers to make entries weekly, and other retailers of beer, ale, cyder, perry, metheglin, or strong waters, brewing, making, or retailing the same, to make entry, monthly, of all the beer, ale, cyder, perry, metheglin, strong waters, or other the liquors aforesaid, brewed or made in that week or month, and obliged them to pay and clear off the duty within the week or month after such entries were made, or to pay double the value of the duty. But none of the said traders are obliged to go out of a market town, nor further than the next market town to the place where he lives, to make such entries.

Various articles which have at different times been chargeable with excise duties, have subsequently been relieved from the burthen, or transferred to other departments. In 1797, the following articles were subject to excise duty, viz:—*auctions*, *bricks*, *glass*, *hops*, *licences*, *malt*, *paper*, *soap*, *spirits* (*british*,) *vinegar*, starch, stone bottles, sweets and mead, tea, tiles, candles, coaches, cocoa nuts and coffee, cider and perry, hides and skins, pepper, printed goods, salt, spirits (foreign,) tobacco and snuff, wine, wire. In 1833, the duty on the twelve last mentioned incidents had been either taken off or transferred to other departments; and in 1835, there remained under the excise survey, only those articles which are printed in italics.* Subsequently, the post horse duties have been transferred to the excise from the board of stamps, and a new excise duty has been imposed on beet root sugar.

### 2. *Of the General Course of Survey for charging the duty.*

The trades subject to Excise survey, may be divided into six classes: 1st, Persons visited for the purpose of charging the "growing duties," as maltsters, soap-makers, brick-makers, paper and pasteboard-makers, glass-makers, distillers, vinegar-makers, hop-planters, and post-masters who let horses for hire. 2nd, Persons whose licence is high or low according to the extent of their manufacture, as brewers, tobacco-manufacturers, &c. 3rd, Persons who are not only liable to Excise licence, but are also subject to a survey, for the purpose of preventing the illegal mixture of duty-paid with unduty-paid articles, as rectifiers, tobacco-manufacturers, &c. 4th, Persons visited because subject to a licence for dealing in articles upon which the Excise duty has, or ought to have been, paid, as inn-keepers who are retailers of spirits. 5th, Persons visited in like manner because subject to a licence for dealing in articles upon which Custom's duty has, or ought to have been, paid, as dealers in tea, coffee, pepper, tobacco, snuff, foreign wine, and spirits. And lastly, Persons from whom no duty for licence, or otherwise, is collected, as malt-roasters, acid-makers, tallow-melters, and two or three others, who are surveyed as a check against their making or receiving unduty-paid articles.†

The duties, except those on licences, auctions, and post horses, are charged by the officers, who visit the several places throughout every part of the united kingdom where the chargeable commodities are manufactured or prepared. There are various regulations applicable to each particular commodity; but the general system is to obtain an account of the materials intended to be used in making the commodity chargeable with duty, or the earliest possible account of the commodity itself, after the process has commenced; and to charge the duty in the stage in which the most certain and satisfactory account of the quantity produced can be obtained. The accounts taken before, and sometimes after, the charge has been made, are intended to prevent the manufacturer from sending any part of his commodity into consumption before the duty has been charged, and introducing fresh materials in the place of the commodities withdrawn. In some cases the officer is authorised to make a presumptive charge upon the trader for a quantity equal to the estimated produce of materials which he may miss from the manufacturer's stock; from which charge the trader may relieve himself by a warrant from two magistrates on proof that such materials were not manufactured into the particular commodity for which the duty is chargeable.

---

* Twentieth Report on the Excise Enquiry.

† See Companion to the Almanack for 1836.

All manufacturers of, and most dealers in, or retailers of any exciseable commodity, are required to make entry of their premises and utensils, and to mark the same, so that the officers appointed to survey them may know each of them with certainty. To these premises and utensils the officers are to be allowed access; and penalties are incurred for any interruption in such surveys, and for carrying on business in any other than in the entered premises and utensils. In most cases, also, the manufacturer is required to give notice to the officer before he commences an operation; and the officer is enjoined to attend at the premises when the most useful accounts can be taken, and on every visit to go through the entered premises, and to record, in his survey book, the state of the materials in the process of manufacture, and the quantity in certain cases where it can be ascertained and may be useful in checking the quantity afterwards produced for charge. From these surveys and entries the charge of duty is ultimately made upon the trader, with whom an account of such duty is left before the time for payment thereof; which, in the usual course of business, is at the collector's round or sittings for the district in which the premises are situate. In many cases, a paper is required to be kept on the traders' premises, called a *Specimen*, in which the officer is required to make entries, corresponding in substance, with the entries in his survey book; and, in other cases, a minute paper is required to be signed on every survey to show that the officer has given due attendance. 7 & 8 G. 4, c.53.

The several charges upon each trader having been recorded in the officer's books as they are made, the whole are added up, and returns thereof are made for each officer's station in London, at periods fixed by law, with regard to the description of goods charged. Out of London, like returns are made *eight* times in the year, viz: at the close of each quarter, (i. e.) 5th April, 5th July, 10th October, and 5th January; and also at about the middle of each of these quarters on days fixed upon by the Board. When all the charges have been made up, the officer transcribes the total amount of each person's charge from the book into an account called a *Voucher*,* one of which is made out for each separate duty, viz: *Malt*, *Soap*, and *Bricks*, &c. The charges on the several traders contained in each such voucher are then added up, and the total is the amount of that particular head of duty arising within the station. The duty, so arising, is computed and set out in the vouchers; from which the officer prepares an account called an *abstract*, containing the total amount of the commodities charged on every trader in his division or ride, and of the duty thereon. These accounts are compared with the books and examined by the supervisor, who forwards the abstract to the collector to apprize him of the sums with which he will be charged by the accomptants at the chief office, and the names of the persons from whom he is to receive the same. The supervisor next transmits the vouchers to the chief office, quite irrespectively of the collector, and such vouchers are the foundation of the charges there raised against him.

Every collector in the United Kingdom commences the collection of the duties (technically called his "round") on the same day, which is fixed by the Board; and is always on the Monday, about nine days or more after the officers have made up their books for each round; and at the different places where he holds his sittings,

---

* At the foot of each voucher the officer is required to insert the total amount of goods and money, in words at length, as shewn in the following

*Specimen of a Malt Voucher.*

MALT.

York Collection, Snaith District, Selby Division—1st Round, 1841, Voucher from Jan. 5th to Feb. 20th, 1841.

| | Net Bushels at 2s. 8½d. $\frac{4}{10}$ | |
|---|---|---|
| John Jennings<br>Thomas Hobson | 435<br>495 | Duty. |
| Total. | 930 | £126 6s. 6d. |

The amount of this voucher is nine hundred and thirty net bushels of malt; cash one hundred and twenty-six pounds six shillings and six pence.
*A. B. Officer.*

the sums, paid to him by the respective traders, are discharged in the ledger by the collector's clerk; and those charged, and for which the credit allowed by law has not expired are set forward, in arrear, to be paid as they become due. A distinction is made between those arrears and the sums which have actually become payable and are not paid at the proper time. When the business of collecting is over for the day, each officer is required to make out an account in his own book of the different sums, arising within his business, which the collector has received that day, and another account showing, under each head of duty, the amount of arrears outstanding against each trader; all which are brought to a total respectively; and, having been compared and examined, the former is signed by the officer and the latter by the collector and supervisor. The total of the sum thus received by the collector, in each such station, is required to be entered by the officer in his *own figures*, in a sheet called the collector's "*Petty Account*," and signed by both officer and supervisor; and each officer also enters in the respective arrear lists, for each duty, the amount of arrears outstanding in his business; which lists, after they have been examined and signed by the supervisor, are sent by him to the proper accountant at the chief office.

The collector's remittances to the board, or payment to the respective Returners of the revenue-cash, are made as soon as possible after the money has been received; and he is not allowed to retain any balances in his hand at the end of any week if it can be avoided, unless under the authority of the board, which is granted to meet only special advances of cash or payments likely to be soon demanded. The collector has also to send up one of the petty accounts at the close of each week, in order that it may be seen what sums have been received by him in that week, and the manner in which the money has been applied (i. e.) whether by remittances, re-payment of duty, allowances, or drawbacks, &c., or in charges of management; for all of which he has to transmit the proper vouchers; and if any material balance remains in his hands at the end of the week, an explanation is required to accompany the account, and; the date of the board's authority, if any.

The vouchers for duties arising in London, are, with the exception of the periods at which they close, made up in the same manner; and the charges on the respective traders are posted into ledgers by the proper accomptants, and discharged by them as the duties are paid by the trader to the Receiver General; who, after repaying duties legally authorised to be drawn-back, and charges of management allowed by the board, pays the balance of the receipts, and the sums remitted by the collectors from the country, into the Bank of England, for being paid into the Exchequer.

Such is the general course of charging and collecting the Excise duties; but there are various modifications of the practice applicable to different trades, which are briefly stated in the ensuing sections.

### 3. *Of the Entry of Places and Utensils.*

Entries of places and utensils for carrying on Excise trades are to be delivered to the officer in whose survey the places and utensils are, whether the act relating to the particular business requires such entries to be given at the next office of excise, or to the officer. And the officer having received any such entry, is to copy the same into the book kept and known by the name of the "*General Entry Book*," for the division or ride in which the places or utensils are situate; and the Supervisor is to examine and compare the copy so made with the original entry; and when an officer is removed, he is to deliver over to his successor such book and all such original entries. 4 & 5 W. 4, c. 51 s. 5.

Every person using any place or utensil without a proper entry is liable to a penalty of 200*l.*: s. 6; and every person using any place or utensil, for any other purpose than that for which it is entered, is liable to a penalty of 100*l.*: s. 7. Not more than one entry is to be in force at the same time for the same place, s. 8, but if a trader absconds or quits without withdrawing his entry, the board may consent to another entry being made, s. 9.

Places and utensils mentioned in any entry are to be distinguished therein by particular letters or numbers, and the same letters or numbers are to be marked on the places or utensils, to the satisfaction of the Supervisor: and fixed pipes are to be painted with particular colours; otherwise the parties will forfeit 100*l.*; 7 and 8 Geo. 4, c. 53, s. 21.

The entry book of the division or ride in which the premises are situate is to be a sufficient proof of the entry or non-entry of any place or utensil, s. 19. No entry is legal unless it be made in the name of the real owner, he being at the time, at least, 21 years of age; but the visible owner is to remain liable to duties and penalties, whether he shall be the entered trader or not, s. 20.

### 4. *Of Licences.*

Most of the licences granted by the Excise are regulated by 6 Geo. 4, c. 81, the 2nd section of which specifies the amount of duty payable thereon respectively; and the 26th section imposes penalties varying from 50*l.* to 500*l.*, for carrying on the trades referred to, without licence.

Every licence is to specify the purpose, trade, or business for which it is granted, the name and place of abode of the person taking it out, and the time of granting it; and (except in the case of auctioneers) the place at which the trade or business is to be carried on, s. 7.

Licences taken out by brewers and distillers, and by publicans as retailers of beer, wine, spirits, or sweets, expire on the 10th of October, annually; all others (except certain trades not within the act) expire on the 5th of July in each year, s. 16.

If a licence be taken out by a beginner in any part of a year, less than three quarters, a proportionate part of the duty only is payable, s. 18.

One licence is not sufficient for different sets of premises, except auctioneers or maltsters, s. 10; but in case of removal, &c. licenses may be transferred to other premises, &c. s. 21.

Licensed persons are required to put their names and business, and the word "Licensed" on their entered premises, s. 25, and to produce their licence for examination by any excise officer, on demand, under a penalty of 20*l.* s. 28.

*See the Duties under the different heads.*

### 5. *Of Permits.*

No permit is to be granted by any officer of excise until a request-note shall have been delivered by or on behalf of the the person requiring the same; 2 W. 4, c. 16, s. 5; and such request-note must contain the name of the place from which, and of the place to which, the commodities are to be removed, and by what mode of conveyance; and the real name and place of abode of the person sending the commodities, and of the person to whom they are to be sent; with such other particulars as the board may require: which request-note must be signed by the person requesting the permit, or by his known clerk or servant, s. 6.

The permit is to limit the time for which it is to be in force; and every permit not used, is to be returned to the officer within the time limited for sending out the goods. s. 8.

Penalty on traders sending out, or delivering, or receiving any goods requiring permit, without such permit, 200*l.* s. 10; and all goods removed without such permit to be forfeited, and the person removing them to forfeit 200*l.* s. 11. When a permit is not delivered with goods requiring the same, the seller cannot recover the price: s. 12. Penalty on forging or counterfeiting a request note, or fraudulently procuring permits, or misapplying or mis-using the same, 500*l.* with forfeiture, s. 13.

The other general regulations relating to permits are all contained in the same statute.

### 6. *Of Exporting Goods on Drawback.*

The person who has paid the duties on the commodities intended to be exported, or who has bought or become lawfully entitled to the same, is required to give *twelve* hours' notice to the proper officer, of the time and place when and where the goods are to be *packed* for exportation; at which time and place the officer attends to see the goods put into the packages; each of which he secures by placing a tape over the parts where the package is made to open, and sealing the tape at the ends with a seal provided by the board; 25 Geo. 3, c. 74, s. 12, 13. The officer makes out a *certificate* bearing an impression of the seal with which the packages are sealed, and describing the marks, number, and contents of each, and whether it be a cask, chest, box, &c. This certificate, after being examined by the surveyor, is transmitted to the officer whose duty it is to see the goods shipped at the port from which they are to be exported.

The exporter is required to give *six* hours' previous notice of his intention to *ship* the goods; and before the shipment to give bond for the due exportation thereof. The notice, with a description of the packages and goods, is then handed over to the Searcher of the customs, whose duty it is to see them on board the ship, and if they agree, to certify the same and return the documents. 25 Geo. 3, c.74, s. 13, 14;—56 Geo. 3, c. 104, s. 25;—57 Geo. 3, c. 87, s. 10.

The debenture for allowing the drawback is then made out, and, within a limited time after the vessel has sailed from the port, is delivered to the exporter, on his making proof, (if it has not been done before the shipment,) that the goods are the same which are described in the packing certificate, and that the duties thereon have been fully paid; and upon the debenture being presented to the collector of the port, the drawback is paid. 25 Geo. 3, c. 74, s. 131; and 2 Wil. 4, c. 4, s. 1.

The officers of excise and searchers of customs, are authorised to open any of the packages for examination, and if the goods do not correspond, or are not of the value of the duty for home consumption they may seize the whole. In cases of disagreement, or of the goods being found of less value than the duty, the exporter incurs a penalty. 57 Geo. 3, c. 87, s. 10; and goods fraudulently produced to obtain drawback, are forfeited, with treble value, or £100; 4 & 5 W. 4, c. 51, s. 12.

*See also the Acts referred to under the different heads of duty, infra.*

### 7. *Of Prosecutions for recovery of duties aud penalties.*

All prosecutions for excise penalties are to be instituted by order of the Commissioners of Excise, and in the name of the Attorney General or of an Officer of Excise, except summary proceedings, for conviction upon an *immediate* arrest. 7 and 8 Geo. 4. c. 53, s. 61, 66.

When an officer makes a detection or receives an information of of penalties incurred it is his duty to represent the same as soon afterwards as possible to his supervisor, or superior officer: and when the Supervisor receives such communication, or himself makes any such detection or receives any such information, it is his duty, after investigating the circumstance, to report the same to the commissioners for their directions thereon. This report is required to be perspicious and *candid*, and to contain every particular which may enable the board to decide whether the case is proper for prosecution.—*See the Board's Instruction for conducting summary proceedings.*

Should proceedings be ordered in the Exchequer, the Solicitor of Excise supplies the officer with all necessary instructions for serving the process and collecting the evidence; and if the proceedings be instituted in the country, they are carried on either by the Collector, or by the Supervisor under his directions; but the Collector is enjoined to attend the *hearing*, before the magistrates, of all informations arising in his collection, unless he is otherwise particularly engaged, which he must specify in under-writing the Supervisor's letter to the board. The commissioners furnish the officers with printed forms of the necessary proceedings, and full instructions for filling them up.

In case of the immediate arrest of a person for being found carrying on an unentered excise manufactory, the magistrates are authorised to hear and determine the case, without the officer's waiting for an order from the board to prosecute; and if the case be proved, the party arrested may be convicted in the penalty of 30*l.*, and, in default of immediate payment, committed to prison for three months. 7 and 8. Geo. 4, c. 53. s. 33.

If Excise duty be in arrear after the proper time of payment, or be in danger of being lost before the usual time of payment arrives, the trader may be proceeded against before the magistrates for the penalty of double duty; and 24 hours' notice of the hearing is sufficient; 4 and 5 W. 4, c. 51, s. 11. In *Scotland* or *Ireland* when duty is in danger, the collector has the power of issuing a warrant for enforcing payment; 7 & 8 G. 4, c. 53, s. 27.

When the duty in danger is of considerable amount, or not likely to be recovered by proceedings before the magistrates, an Extent out of the Court of Exchequer can be obtained for recovery thereof; for which purpose, in England, the Supervisor (generally under the Collector's directions,) proceeds to London to make the necessary proof of the debt and insolvency.

Besides the ordinary remedies for recovering excise duties in arrear, there is a special lien for such duties, on the excise utensils, goods and materials, whether remaining in the hands of the trader or not; 7 and 8 Geo. 4, c. 53, s. 28.

Penalties recovered under the Excise laws, (except those on bonds, see general order, Sept. 7, 1821,) are (after payment of expences) to be divided between the crown and the informer; 7 and 8 Geo. 4, c. 53, s. 103; and in special cases the board are authorised to pay the expences out of the revenue, s. 105, 106, 4 and 5 Wil. 4, c. 51, s. 14. And when a seizure is condemned and destroyed for being adulterated, a reward is payable to the officer; s. 13.

### 8. *Of Complaints of Overcharge.*

The Commissioners of Excise within the limits of the chief office, or two Justices elsewhere, upon complaint of any overcharge or overpayment within twelve calendar months, or of any title to a return of duty within the time limited by law, may hear and determine such complaint, and, by warrant, order the payment or repayment of such duty as the party shall appear entitled to; but in London, the complaint must be entered in a book kept in the office of the Solicitor of Excise, and in the Country, eight days' notice of the hearing must be given to the proper Collector or Supervisor. 4 & 5 W. 4, c. 51, s. 27.

## PART II.—ALPHABETICAL ARRANGEMENT OF DUTIES, &c.

### Auctions.[*]

### 1. *Duties.*[†]

| | £ | s. | d. |
|---|---|---|---|
| **GREAT BRITAIN.**—43 *G.* 3, *c.* 69, 6*d.*—45 *G.* 3, *c.* 30, 1*d.* For every twenty shillings of the purchase money arising or payable by virtue of any sale at auction in Great Britain; of any interest, in possession or reversion, in any freehold, customary, copyhold, or leasehold lands, tenements, houses, or hereditaments, and any share or shares in the capital or joint stock of any corporation or chartered company, and of any annuities or sums of money charged thereon, and of any ships and vessels, and of any reversionary interest in the public funds, and of any plate or jewels; and so in proportion for any greater or less sum of such purchase money - - | 0 | 0 | 7 |
| 43 *G.* 3, *c.* 69, 10*d.*—45 *G.* 3, *c.* 30, 2*d.* For every twenty shillings of the purchase money arising or payable by virtue of any sale at auction in Great Britain, of furniture, fixtures, pictures, books, horses and carriages, and all other goods and chattels whatsoever, and so in proportion for any greater or less sum of such purchase money - - - - - | 0 | 1 | 0 |
| **IRELAND.**—54 *G.* 3, *c.* 82. For and upon every twenty shillings of the purchase money arising or payable by virtue of any sale at auction in Ireland; | | | |
| Of furniture, fixtures, pictures, books, horses, and carriages, and all other goods and chattels whatsoever, not herein otherwise charged, and not exempt by law | 0 | 0 | 10 |

---

[*] Auction Duty was first imposed in Great Britain, by 17 G. 3, c. 50, but was not extended to Ireland until 1797. The net receipts in 1839 (exclusive of licences) were as follow; England, £263,567; Scotland, £21,014; Ireland, £13,824.

[†] EXEMPTIONS.

*See, as to Sales held by Order of Public Boards, &c.*, 19 G. 3, c. 56, s. 13; 41 G. 3, c. 26, s. 3; 42 G. 3, c. 116, s. 113; 54 G. 3, c. 82; 55 G. 3, c. 55 s. 12; 10 G. 4 c. 50, s. 78.—*Bankruptcy and Insolvency*, 19 G. 3, c. 56, s. 15; 54 G. 3, c. 82; 54 G. 3, c. 137, s. 74; 6 G. 4, c. 16, s. 98; 7 G. 4, c. 57, s. 87; 10 G. 4, c. 55, s. 15, 1& 2 V. c. 110, s. 116—*Executions*, 19 G. 3, c. 56, s. 15; 54 G. 3, c. 82—*Distresses for Rent*, 19 G. 3, c. 56, s. 13; 54 G. 3, c. 82—*Agricultural produce*, 19 G. 3, c. 56, s. 14; 54 G. 3, c. 82.—*Manufactures*, 29 G. 3, c. 63,

| | £ | s. | d. |
|---|---|---|---|
| Of any interest, in possession or reversion, in any freehold or leasehold lands, tenements, houses, or hereditaments, and of any annuities, debts, or sums of money chargeable thereon, or otherwise, and of any utensils of husbandry and of farming stock, and of ships and vessels, and of any article of gold or silver, and jewels, except in cases where the same are otherwise charged or exempted by law | 0 | 0 | 6 |
| UNITED KINGDOM.—55 *G.* 3, *c.* 142. For every twenty shillings of the purchase money arising or payable by virtue of any sales at auction in Great Britain, for the benefit of the growers or first purchasers respectively, of any sheep's wool, the growth or produce of any part of the United Kingdom | 0 | 0 | 2 |
| By treasury warrant dated 10th September, 1816. On the auction sale price of all imported goods, except Irish goods imported from Ireland, on the first sale thereof when made by or on account of the first importer—per cent | 0 | 10 | 0 |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2. For and upon every Excise licence to be taken out by every person exercising or carrying on the trade or business of an Auctioneer, or selling any goods or chattels, lands, tenements, or hereditaments by Auction, within *Great Britain* or *Ireland*, the annual sum of | 5 | 0 | 0 |
| ADDITIONAL.—3 & 4 *V.* *c.* 17, *s.* 1, From May 15, 1840, upon the produce and amount of all the foregoing duties, an additional duty of | £5 *per cent.* | | |

### 2. *Regulations for securing the Duty.*

Every Auctioneer is required to enter into a bond, with two sureties, for duly accounting for and paying the duties within *twenty-eight* days after every sale, if held within the limits of the chief

---

s. 1; 54 G. 3, c. 82.—*Damaged, Condemned, and Wrecked property*, 19 G. 3, c. 56, s. 15, 17; 54 G. 3, c. 82; 1 and 2 G. 4, c. 75, s. 38; 1 and 2 G. 4, c. 67, s. 20.—*Foreign property*, 19 G. 3, c. 56, s. 15; 28 G. 3, c. 37, s. 12; 30 G. 3, c. 26, & 29; 32 G. 3, c. 41; 41 G. 3, c. 42; 41 G. 3, c. 91, s. 8; 42 G. 3, c. 93, s. 3; 47 G. 3, s. 2 c. 65; 52 G. 3, c. 53, s. 1; 54 G. 3 c. 82; 57 G. 3, c. 36; 59 G. 3, c. 54, s. 3; 1 G. 4, c. 9, s. 3; 5 G. 4, c. 75, s. 2; 1 and 2 W. 4, c. 52, s. 8.—Treasury Warrant, 21st Oct. 1815; 19th Feb. 1820; 10th March, 1820; 21st Sept. 1821; 26th Oct. 1825; 6th Jan. 1829; 18th March, 1833; 18th July 1834; 18th June, 1840.—*Foreign Ministers*, Board's Order, May 2, 1822.—*Property bought in by the Owner*, 19 G. 3, c. 56, s. 12; 28 G. 3, c. 37, s. 20; 42 G. 3, c. 93, s. 1, 2; 54 G. 3, c. 82, s. 22.

Office of Excise, London, and within *six* weeks elsewhere. 19 G. 3, c. 56, s. 7 and 8; 42 G. 3, c. 93, s. 14 and 15; 43 G. 3, c. 130, s. 1. If the Auctioneer sells within the limits of the chief office of Excise he is to give notice thereat *two* days, at least, before he begins to hold any sale, and then, or within *twenty-four* hours afterwards, to deliver a catalogue of all the articles intended to be sold; and if he intends selling elsewhere, he is to give notice to the Collector, or at the Excise Office, nearest the place of sale, *three* days before the sale, and deliver a catalogue, then, or within *twenty-four* hours afterwards, under a penalty of £20. 19 G. 3, c. 56, s. 9. But Auctioneers may sell the hull and materials of any vessel, *wrecked*, or *stranded* on the coast in England on 24 hours notice, where peculiar circumstances require it, the Board being specially informed thereof.—*Board's Order*, 6th October, 1837.

The Auctioneer, or his Clerk, is within *twenty-eight* days after any such sale, if within the limits, and within *six* weeks, if elsewhere, to deliver a declaration to the proper officer, setting forth whether or not a sale was opened under the notice given, or any article, lot or parcel enumerated in the catalogue bid for, or sold. 32 G. 3, c. 11.

Any Auctioneer holding a sale in the country is allowed to settle for it at the chief office, or in any other collection, on giving notice of his intention to do so. But in such case, he is required to deliver his return in duplicate. 19 G. 3, c. 56, s. 19. And where goods are sold under any *execution*, or for the benefit of *insurers*, the sheriff or insurers are to certify truly as to the particular goods sold, 19 G. 3, c. 56, s. 16, 17.

The duties are to be paid within the time limited, under a penalty of double duty, 38 G. 3, c. 54, s. 2; 4 & 5 W. 4, c. 51.

If any sale be rendered void for want of title, *three* Commissioners of Excise, or *two* Justices of the Peace, may within *twelve* calendar months next after the sale, grant relief. 19 G. 3, c. 56, s. 11; 28 G. 3, c. 37, s. 19; 51 G. 3, c. 95, s. 1, 38 G. 3, c. 54, s. 3; and 4 & 5 W. 4, c. 51, s. 27. And if property has been bought in by the Owner, or by an under-bidder appointed under regular notice, the duty is not enforced. 19 G. 3, c. 56, s. 12; 28 G. 3, c. 37, s. 20; 42 G. 3, c. 93, s. 1, 2.

As to Auctions in Ireland, see 54 G. 3, c. 82, and 58 G. 3, c. 79.*

---

* The statutes are set out at length in the "LAW OF AUCTIONS" (Maxwell, 1838,) which also contains various forms, tables, and practical directions.

## Beer and Cider.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 6 *Geo.* 4, *c.* 81, *s.* 2. Every brewer of table beer[†] only for sale, if the quantity of beer brewed by such brewer within the year ending the 10th day of October previous to taking out such licence, shall not exceed 20 barrels, the annual sum of | 0 | 10 | 0 |
| If the same shall exceed 20 barrels, and shall not exceed 50 barrels | 1 | 0 | 0 |
| If the same shall exceed 50, and shall not exceed 100 barrels | 1 | 10 | 0 |
| Or if the same shall exceed 100 barrels | 2 | 0 | 0 |
| Every brewer of beer (other than table beer only) for sale, if the quantity of beer brewed by such brewer within the year ending the 10th day of October, previons to taking out such licence, shall not exceed 20 barrels | 0 | 10 | 0 |
| If the same shall exceed 20, and shall not exceed 50 barrels | 1 | 0 | 0 |
| If the same shall exceed 50, and shall not exceed 100 barrels | 1 | 10 | 0 |
| If the same shall exceed 100, and shall not exceed 1000 barrels | 2 | 0 | 0 |
| If the same shall exceed 1000, and shall not exceed 2000 barrels | 3 | 0 | 0 |
| If the same shall exceed 2000, and shall not exceed 5000 barrels | 7 | 10 | 0 |
| If the same shall exceed 5000, and shall not exceed 7500 barrels | 11 | 5 | 0 |
| If the same shall exceed 7500 and shall not exceed 10,000 barrels | 15 | 0 | 0 |

---

[*] Beer was one of the first articles on which an Excise duty was imposed, see p.280, but the duty (except on licences) was taken off by 1 W. 4, c. 51.

[†] In consequence of the repeal of the duty on beer, there is now no distinction between table beer brewers and other brewers; and by 1 W. 4, c. 51, the rate of the brewer's licence is to be calculated according to the quantity of malt he may consume in his brewery, viz. one barrel for every two bushels of malt, and not according to the number of barrels of beer he brews.

By Treasury order, November 9, 1830, no objection is to be made to the sale of table beer only by retail *without licence* provided it be not sold at a higher price than 1¼d. per quart.

| | £ | s. | d |
|---|---|---|---|
| If the same shall exceed 10,000, and shall not exceed 20,000 barrels | 30 | 0 | 0 |
| If the same shall exceed 20,000, and shall not exceed 30,000 barrels | 45 | 0 | 0 |
| If the same shall exceed 30,000, and shall not exceed 40,000 barrels | 60 | 0 | 0 |
| Or if the same shall exceed 40,000 barrels | 75 | 0 | 0 |
| Every person who shall first become a brewer of beer for sale, on taking out such licence as aforesaid for that purpose, shall pay the sum of ten shillings and within ten days after the tenth day of October next after taking out such licence, pay such further additional sum as, with the said sum of ten shillings, shall amount to the duty herein-before mentioned, according to the number of barrels of beer brewed within the preceeding year or period, for which such licence was granted | 0 | 10 | 0 |
| Every brewer of beer for sale, who shall retail such beer to be consumed elsewhere than on his, her, or their premises | 5 | 5 | 0 |
| Every person not being a brewer of beer who shall sell strong beer only in casks, containing not less than 4½ gallons imperial standard gallon measure, or in not less than two dozen reputed quart bottles at one time to be drunk or consumed elsewhere than on his, her, or their premises | 3 | 3 | 0 |
| Every person who shall be duly authorised by Justices of the Peace, to keep a common inn, alehouse, or victualling-house, and who shall sell beer, cider, or perry, by retail, to be drunk or consumed in his, her, or their premises, if the dwelling house in which such person shall reside or retail beer, cider, or perry, as aforesaid, at the time of taking out such licence, shall not, together with the offices, courts, yards, and gardens therewith occupied, be rated under the authority of any act or acts of parliament for granting duties on inhabited houses at a rent of twenty pounds per annum or upwards, or shall not be rented or valued at such rent or annual value or upwards | 1 | 1 | 0 |

| | £ | s. | d. |
|---|---|---|---|
| And if rated, rented, or valued as aforesaid, at twenty pounds per annum, or upwards - - - - | 3 | 3 | 0 |
| 4 & 5 *W.* 4, *c.* 85, *s.* 13. For and upon every licence to be taken out by any person for the selling by retail of beer not to be drunk or consumed in or upon the house or premises where sold *in England*, the annual sum of - - - - - - | 1 | 1 | 0 |
| For and upon every licence to be taken out by any person for the selling by retail of beer, to be drunk or consumed in or upon the house or premises where sold in *England*, the annual sum of - - - - - | 3 | 3 | 0 |
| CIDER.—1 *W.* 4, *c.* 64, *s.* 30. Licence to sell Cider by retail in any part of *England*, in any house or premises specified in such licence - - - - - | 1 | 1 | 0 |
| ADDITIONAL.—3 & 4 *Vic. c.* 17, *s.* 1, from May 15, 1840, upon the produce and amount of all the foregoing duties, an additional duty of - - - | £5 *per cent.* | | |

## 2. *Excise Regulations.*

Brewers are to make entry of their mash-tuns, and store-rooms; and they are prohibited from using any malt or hops, except such as are taken from the rooms so entered; and officers are to be permitted to visit and survey them. 1 W. 4, c. 51, s. 15, 16; 7 & 8 G. 4, c. 52, s. 54, 55.

The licences of Beer Retailers, not being publicans, are granted on the certificate of a certain number of householders, and on a bond being entered into with sureties. 1 W. 4, c. 51, s. 1, 2; 4 & 5 W. 4, c. 85, s. 1, 3.

In brewing Beer for sale, the brewer is only to use malt, hops and water, under a penalty of £200; and any person knowingly selling adulterating articles of any kind to any brewer, dealer or retailer, is liable to the penalty of £500. 56, G. 3, c. 58, s. 2, 3; and see as to *Ireland*, 7 & 8 G. 4, c. 52, s. 64, &c.

And no Brewer is to keep any unmalted grain in his entered premises, or in any mill connected with them, under a penalty of £200.; 1, W. 4, c. 51, s. 17.

Before putting any water upon his malt for brewing, the brewer is to enter in an Excise book or paper, the date of such entry, the quantity of malt intended to be used, and the date of the brewing; and he is not to remove any such malt from the mash-tun after all the worts have been drawn off, until the officer shall have gauged the same, or within an hour after the time specified ; nor to mix worts with any yeast, until the officer has taken a sample thereof, or within one hour after the time specified in the notice. 1 & 2 G. 4, c. 22, s. 1, 2 and 3.

Beer Retailers are prohibited from mixing adulterating ingredients with Beer; 1, W. 4, c. 64, s. 13; and from having spirits in their possession. 4 & 5 W. 4. c. 85, s. 16.

The Police regulations respecting public houses are contained in 9 G. 4, c. 61, for England; and in 9 G. 4, c. 58, for Scotland.

Beer, in respect of the malt used in brewing it, is entitled, on exportation, to a drawback.—*Vide Malt infra.*

## Beet-Root Sugar.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 1 *V. c.* 57, *s.* 1. On every hundred weight of sugar manufactured in the United Kingdom from Beet-Root, and so in proportion for any greater or lesser quantity than a hundred weight - - - - - | 1 | 4 | 0 |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1, From May 15, 1840, upon the produce and amount of the foregoing duty, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Regulations for charging the duty.*

Every manufacturer is to make entry of his premises and utensils, 1 V. c. 57, s. 3; which are to be marked and numbered, s. 4; and the officers of Excise are empowered to enter and survey, s. 5. The utensils are not to be used until gauged, s. 6, nor altered after being gauged, except on notice, s. 7.

Notice is to be given of every grinding or mashing of Beet-Root to be made into sugar, s. 8 ; and when the juice or syrup is collected, a declaration of the quantity and gravity is to be given to the officer, who is to attend and take an account of it, s. 9. The officer may take samples, which are to be deemed the gravity of the whole contents of the cistern, s. 10. The juice, after the quantity and gravity has been ascertained, is to be run off to the sugar pan and kept separate during the process of the manufacture until charged, s. 11. And when the manufacture of sugar is complete, notice is to be given of the time when it will be ready to be weighed, s. 12. There are two modes of charging the duty, first, from the gravity of the syrup, s. 13. Secondly, by the weight of the sugar produced, s. 14. And the officer is to make a return of the duty every six weeks, and charge the maker by whatever mode will produce the highest amount of duty, s. 15.

---

[*] This was the first imposition of an Excise duty on Beet-Root Sugar. The net receipts in 1839, were only £9.

The Commissioners of Excise may prescribe a saccharometer to be used for ascertaining the gravity of the syrup, s. 16. The maker to keep scales and weights, s. 17, and to assist with his servants in weighing, s. 18. Charged and uncharged sugar to be kept separate, s. 19. Penalty on evading the duty £500, s. 20.

## Bricks.

### 1. *Duties.**

| | £ | s. | d. |
|---|---|---|---|
| 2 & 3 *V. c.* 24, *s.* 2. For and upon every 1000 Bricks of a size not exceeding 150 cubic inches each brick, which shall be made in *Great Britain*, or which shall be brought from Ireland into Great Britain, a duty of | 0 | 5 | 10 |
| For and upon 1000 bricks exceeding the foregoing size, which shall be made in *Great Britain*, or which shall be brought from Ireland into Great Britain, a duty of | 0 | 10 | 0 |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1. From May 15, 1840, upon the produce and amount of the foregoing duty, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Drawbacks.*

| | |
|---|---|
| 2 & 3 *V. c.* 24, *s.* 22. For all bricks made in *Great Britain*, on which the duties imposed in respect thereof shall have been charged, and which shall be duly removed to *Ireland*, or exported to Foreign parts, as merchandize, a drawback of - - | *The Duties paid.* |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 3. On all goods and commodities entitled to drawback on the exportation or removal thereof to foreign parts, or Ireland, which shall, after Aug. 15, 1840, be so exported or removed, an additional drawback of - - - | £5 *per cent.* |

---

* The Excise duty was first laid on Bricks and Tiles, by 24 G. 2, c. 24. The duty on the latter commodity was repealed in 1839. The net revenue arising from the Brick duty in 1839, was in England, £450,427, and in Scotland, £12,999.

### 3. *Process of Manufacture.*

The clay, previously tempered and prepared, is brought to a bench on which a mould of the proper size and form required, is placed. The workman then fills the mould with clay, strikes off the superfluous part thereof and smooths the surface, when the brick is completed. It is afterwards removed and laid on the ground, in a place (called the flats) to dry. When sufficiently hardened, the bricks are placed one upon another in hacks, resembling walls, in which state they remain until they are dry enough to go to the kiln or clamp to be burnt, a process which requires from a month to six weeks, according to the weather. In many instances, however, the bricks are taken directly from the mould to the hack, but this cannot be done with strong clay, which requires to be moulded in a wet mould.

### 4. *Regulations for charging the Duty.*

Every brickmaker is to make entry with the Excise of his brick-fields, sheds, &c. 2 & 3 V. c, 24, s. 4, and the officer is thereupon empowered to enter and survey, s. 5.

The bricks are to be taken account of and charged whilst drying, and before being removed to the kilns or clamps for burning, s. 6; but in charging the duty, ten per cent. is to be allowed for waste; s. 7. When drying, the bricks are to be placed in such form that the officer may readily and securely take an account of them, under the penalty of £50. s. 8.

The maker is to provide a mould for determining the size of irregularly shaped bricks, and whether liable to the higher or lower rate of duty, s. 9: which mould, is to be kept securely, and delivered to the officer on demand; and the trader and his servants are to assist in using it, if required. s. 10.

Bricks are not to be removed to the kiln or clamp for burning until charged, s. 11; unless the officer shall neglect to attend on notice s. 12. Charged and uncharged Bricks are to be kept separate s. 13; and not concealed s. 14.

The officer is to make a return of the duty at the expiration of every *six weeks*, or as the Board shall direct; and the maker is to clear off such duty under a penalty of double the amount, s. 15.

All bricks whether moulded or not, come within the Act, s. 16; and nothing is to be deemed to be a tile, which shall not, when turned out of the mould, (except tiles for covering buildings or draining lands) be a perfect square, or be thicker than 1·7 inch, if under 8 inches square, or than 2½ inches, if more than 8 inches square, or which shall have any incision so as to allow of being easily separated. But the commissioners may determine that tiles, not square, are not bricks on being satisfied that they are to be used as tiles, s. 17.

Bricks may be made free of duty, for draining wet and marshy land, on being stamped with the word "drain," s. 18. And an allowance of the duty is made in certain cases when the bricks have been used in building churches; 3 G. 4, c. 72, s. 27.

Bricks are to be entered on being brought from Ireland, and the duty paid thereon; 2 & 3 V. c. 24, s. 19.

Bricks are allowed, on account of their bulk, to be exported without being enclosed in packages. In that case, the officer to whom the shipping notice is given, (a packing certificate being unnecessary,) delivers it to the searcher of customs; and upon the number shipped being certified by him the debenture is made out, s. 24.

For the purpose of charging the duty, the officer is to survey each entered Brick-yard in his residence once every day, Sundays excepted; and those out of residence four times a-week, or five times a fortnight, according to the nature of the business.—*Board Instructions.*

## Coffee, Tea, Cocoa-Nuts, Chocolate, and Pepper.

### 1. *Duties.*

| | £ | s. | d. |
|---|---|---|---|
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2. Every person trading in, or selling coffee, tea, cocoa-nuts, chocolate or pepper, within *Great Britain* or *Ireland*, the annual sum of - | 0 | 11 | 0 |
| ADDITIONAL—3 *&* 4 *V. c.* 17, *s.* 1. From May 15, 1840, upon the produce and amount of the foregoing duty, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Excise Regulations.*

Every dealer in coffee, tea, cocoa-nuts, chocolate or pepper, is to make entry of his premises, which are to be open to the inspection of the officers; 10 G. 4, c. 10, s. 10, 12. See also 9 G. 4, c. 44, s. 1, 4; and *Board's Orders, dated* 26*th July*, 1828, *and* 1*st of March*, 1836.

*For the penalties for adulterating Coffee or Cocoa, see* 43 G. 3, c. 129, s. 5; *Tea*, 11 G. 1, c. 30, s. 5; 4 G. 2, c. 14, s. 11; 17 G. 3, c. 29, s. 1, 2, 3; *Pepper*, 59 G. 3, c. 53, s. 22.

## Glass.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 1 *&* 2 *Vic. c.* 44, Sch. For every hundred weight of the materials or metal or other preparations whatever, by what name soever the same may be called or known, which shall be made use of in the making of Plate Glass, and so in proportion for any greater or less Quantity. - - - - - | 3 | 0 | 0 |
| For every hundred pounds weight avoirdupois, and so in proportion for any greater or less quantity, of the fluxed materials or metal or other preparations whatever, by what name soever the same may be called or known which shall be made for the purpose of making Flint Glass, the sum of - - - | 0 | 6 | 8 |
| For every hundred weight of Crown Glass and German Sheet Glass, [and, by 3 & 4 Vic. of all Broad or Spread Glass,] and so in proportion for any greater or less quantity - - - - - - | 3 | 13 | 6 |
| For every hundred weight of common Bottles and all other vessels and utensils made of common bottle metal, and so in proportion for any greater or less quantity - - - - - . | 0 | 7 | 0 |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2. Every glass maker within *Great Britain* or *Ireland*, for each and every Glass House, the annual sum of - - - | 20 | 0 | 0 |
| ADDITIONAL.—3 *&* 4 *V. c.* 17, *s.* 1. From May 15, 1840, upon the produce and amount of all the foregoing duties, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Drawbacks.*

| | | | |
|---|---|---|---|
| 1 *&* 2 *V. c.* 44, Sch. For every square foot, superficial measure, of ground and polished Plate Glass made from materials or metal or other preparations for or upon which the duties payable in respect of Plate Glass shall have been charged, which shall be exported to foreign parts, and so in proportion for any greater or less quantity - - - - - | 0 | 2 | 9 |

---

[*] A duty upon Glass Wares was first imposed in Great Britain by 6 & 7 W. and M., but repealed by 10 & 11 W. 3; and again laid on permanently, by 19 G. 2, c. 12. In Ireland, a duty on glass bottles was first granted in 1797, and on flint and other glass in 1825. The net revenue arising from this duty in 1839, (exclusive of licences,) was as follows:—England, £645,761; Scotland, £34,917; Ireland, £10,343.

| | £ | s. | d. |
|---|---|---|---|
| For every one hundred pounds weight avoirdupois, and so in proportion for any greater or less quantity, of Flint Glass, for or in respect of which, or of the materials, metal, or other preparation from which the same shall have been made, all Excise duties payable thereon shall have been duly charged, and which shall be exported to foreign parts | 0 | 18 | 9 |
| For every hundred weight of Crown Glass and German Sheet Glass, [and by 3 & 4 V. c. 22, s. 2, after 1st Jan. 1841, of broad or spread Glass,] for which the duties shall have been charged, and which shall be exported to foreign parts, or the islands of Guernsey, Jersey, Alderney, or Sark, in shades or in whole tables or half tables or quarter tables, and so in proportion for any greater or less quantity than a hundred weight of such shades, table, half tables, or quarter tables, calculating the drawback upon the weight of the whole table exported, although the same may be cut into half or quarter tables for convenience of exportation | 3 | 13 | 6 |
| For every hundred weight of panes of Crown Glass for which the duties shall have been paid, and which shall be exported to foreign parts, such panes being in regular rectangular figures of not less dimensions than six inches in length by four inches in breadth, nor containing any part of the bullion or thick centre of the table from which such panes shall have been cut, and so in proportion for any greater or less quantity than a hundred weight | 4 | 18 | 0 |
| For every hundred weight of panes of German Sheet Glass, [and by 3 & 4 V. c. 22, s. 2, after 1st Jan. 1841, of all broad or spread Glass], for which the duty shall have been charged, and which shall be exported to foreign parts, such panes being in regular rectangular figures of not less dimensions than six inches in length by four inches in breadth, and in proportion for any greater or less quantity than a hundred weight | 4 | 0 | 0 |
| For every hundred weight of Common Bottles, and of all other vessels and utensils of common bottle metal, for which the duties shall have been paid, and which shall | | | |

| | £ | s. | d. |
|---|---|---|---|
| be exported, and in proportion for any greater or less quantity - - - - - - | 0 | 7 | 0 |
| ADDITIONAL.—3 & 4 *Vic. c.* 17, *s.* 2. On all drawback due on the exportation of all such goods and commodities to foreign parts, and which shall after Aug. 15, 1840, be so exported, an additional drawback of - | £5 *per cent.* | | |

### 3. *Process of Manufacture.*

The *materials* used for making glass are chiefly sand, silex, and fixed alkalies. These materials are melted so as to produce a fluid, which when cold, constitutes glass, but which, while liquid, may be moulded, blown, drawn, or cast into any shape. *Glass-houses* are commonly made of a conical form, a large vault being made in the interior of the cone, and extending from side to side. Over this vault is a furnace for melting the materials, in earthen pots or crucibles, which, for that purpose, are inserted in holes or arches in the furnace. When the glass has been fused in the crucibles, it is taken out and blown or shaped, into the required form by means which will be afterwards described; after which, for most kinds of wares, the glass is deposited in another furnace called an *annealing arch*, the heat and temperature whereof is allowed to diminish by slow degrees, so as to temper and harden the glass; and this finishes the process of the manufacture. *Crown Glass.*—When the materials have been fluxed and the metal is found sufficiently pure for the purpose intended, a quantity is taken out of the pot on the end of an iron pipe, to which it readily adheres, and is blown, while in a soft state, into a globular form: it is then taken on the end of an iron rod, and introduced into a furnace when it becomes oblate; after which it is carried to the flashing furnace where it opens, by a rotary motion, into a circular sheet, called a table, which is immediately deposited in the annealing arch. *Flint and Phial Glass.*—The metal is taken out of the pot, in the same manner as for crown glass, and then blown and shaped, or moulded into the articles required. *Cast Plate Glass.*—The fluid metal, having been carefully skimmed, is laded from the pot, in which it is founded, into others, called casting cisterns or cuvettes, placed in the refining furnace; after which it is cast upon an iron table, a roller being passed over the metal while in a fused state, to regulate its thickness. The plate is afterwards annealed, and then ground and polished. *Blown Plate* is made in nearly the same manner as crown glass. *Spread Window or Broad Glass.*—The quantity of metal required is taken out of the pot on the end of the punty, and after it has been blown into a cylindrical shape, but somewhat conical, it is opened at one end by means of fire: it is then carried to the '*stokel*' or *oven*, wherein, by the application of a cold iron, it is split down the side, and opened, and spread upon a convex stone till it is quite flat, when it assumes the shape of a trapezoid, being rather wider at one end than the other. It is then annealed. *German Sheet Glass.*—The metal is taken out of the pot as in the last case, and blown and shaped into cylinders similar to broad glass, except not being conical. It is then opened at one end by means of fire and at the other by separating it from the pipe, and it is afterwards cut down the side with a diamond, and placed in the flattening arch, in which it is gradually heated till the cylinder gives way and falls open in the shape of a square, or oblong table, and it is then flattened by means of pressure. *Common Bottles.*—The metal is taken from the pots, on the end of the punty as before described, and blown into bottles and other utensils of the form required, (some being blown and shaped in matrices) and they are immediately deposited in the annealing arches (called "bottle arches") to be annealed.

### 4. *Regulations for securing the Duty.*

Every glass maker is to make entry of his premises and utensils which are to be marked with particular numbers, &c., 1 & 2 V. c. 44, s. 3, 4; and the Officers are empowered to survey, s. 5.

Pots for making *Plate or Flint Glass* are not to be put into the annealing arch until they have been examined, gauged, and marked by the officer, and re-gauged by the Supervisor, s. 6; who as soon as he has gauged any pot, is to give a copy of the dimensions, &c., to the glass maker, s. 7. *The circular divisor for ascertaining the contents of Plate Glass, is* 14·3876 *and of Flint Glass,* 11·00; s. 8.

Makers of Plate and Flint Glass are to give *two* hours' notice, before beginning to heat their annealing pot-arches, s. 9; and a like notice before beginning to fill and charge pots with materials; s. 11; and makers of Flint Glass are also to give *two* hours notice of setting pots in the furnace, and not to change or alter their position, except on emergency and on notice; s. 10. In order to charge the duty on Plate or Flint Glass materials, the officer is to gauge the dry inches or unoccupied space between the top rim or lip of the pot, and the surface of fluid metal; and deduct such quantity or weight from the quantity which, according to the original gauge, the whole pot is denoted to be capable of containing, s. 12. Metal is not to be added after gauge, s. 13; and the officer may take samples not exceeding 4 oz. paying, if demanded, 1d. per oz., s. 14. When metal for making Plate or Flint Glass, is lost by the pot breaking or cracking, the Supervisor may make an allowance thereon; s. 15.

In all fixed pots, an allowance is to be made for waste, of one third of the metal and four inches at the bottom, for *blown Plate Glass*, and one half of the metal and four inches at the bottom, for *Cast Plate Glass*, s. 16; but when the pots are not two-thirds full, only one-fourth to be allowed for blown plate, or one-third for cast plate glass, 3 & 4 V. c. 22, s. 9; and when moveable pots are used as founding pots and casting cisterns of Cast Plate Glass, only two inches at the bottom are to be allowed, 1 & 2 V. c. 44, s. 17. Fluxed materials for plate glass, may be laded out in certain cases, on notice, s. 18; and, the bottoms of pots may also be worked out on notice, and the duty charged on the quantity worked out, 3 & 4 V. c. 22, s. 10. Makers of *Plate Glass* are to give notice, whether the metal in any pot is for blown plate or cast plate glass, and if the notice is departed from, part of the allowance is to be forfeited, 1 & 2 V. c. 44, s. 19. Such makers may break down imperfect plates, and obtain an allowance, on giving proper notice and after due inspection thereof by the Supervisor, s. 20.

Makers of *Flint Glass* are to give *two* hours notice of unstopping pots under a penalty, which however, is not to be incurred, if the pots break or crack, s. 21; nor for unstopping pots during the time of filling or charging, s. 22. Any officer may unstop pots to examine the metal, s. 23. All the pots charged for flint glass are to be unstopped at the same time, s. 24; but flint glass makers on notice, may charge "overtakers," s. 25. The metal in any pot within twenty hours after beginning to charge, may, on notice, be laded into water to improve it, s. 26. Each journey to be finished, and the metal worked out into wares by six o'olock on Saturday night, or such as cannot be worked out, to be laded out under notice, and the weight deducted, s. 27.

Every maker of Flint Glass is to make entry of his annealing lears, s. 28; each of which must be constructed with parallel sides, one mouth, and one discharge-hole, opening into the weighing-room; and they must also be progressively numbered, s. 29. He is likewise to provide fastenings for securing the mouth of every lear, which fastenings are to be locked and secured by the officers, s. 30: Also a weighing and reweighing-room with proper communications and fastenings, s. 31: Also pans and trays for receiving goods in the lear, and proper machinery for working such pans and trays in the lear; and for drawing them through the lear into the weighing-room, s. 32. But rollers and machinery need not be applied to the lear used for annealing goods for cutting, s. 33. *Two* hours notice to be given for heating a flint glass lear; s. 34. Glass of different makings not to be annealed at the same time, s. 35. All articles requiring to be annealed are, as soon as made, to be deposited in a pan or tray, placed within the mouth of the lear; and as the pans or trays are filled, are to be drawn down into the lear, and from thence into the weighing-room, s. 36. Before locking up the lear at the close of the journey, a declaration of the number of pans is to be given under a penalty, which is not to be incurred if the number does not exceed the declaration above two *per cent*, s. 37. *One* hour's notice is to be given for regulating the pans, s. 38, and *six* hours notice for opening the weighing-room, and charging the goods; and the officer is to attend at the time mentioned in the notice, and unlock the fastenings and weigh the goods in the weighing-room (except such as may be selected to be broken down,) and charge the duty; but no notice is to be given for any other time than between six A.M., and six P.M., s. 39. In weighing, the reweighing-room door is to be and continue fastened the whole time; and after the weighing, the goods are to be immediately removed into the reweighing-room, and kept there *four* hours, unless the supervisor shall sooner reweigh them; and any additional weight discovered on reweighing, is to be charged; and the supervisor is to examine the glass, selected for breaking down and satisfy himself that it is so broken down; and immediately after reweighing the goods, they are to be removed from the reweighing-room, s. 40 and 45.

Flint Glass which does not require to be annealed, is to be deposited in a properly constructed room for the purpose; such room communicating with the glass-house, and having only one entrance door, which is to be kept locked by the officer when any glass is deposited therein, and only to be opened on notice, s. 41. *One* hour's notice is to be given of the intention to make any such goods; s. 42, and when made, the same are to be placed in baskets or trays and carried immediately into the room for unannealed goods, and to remain there until charged with duty, s. 43. *Six* hour's notice, is to be given for weighing such goods, s. 41; and they are to remain in the room after being weighed for *four* hours, unless sooner reweighed by the supervisor; s. 44.

Flint Glass goods may be selected and declared imperfect, and thereupon such articles are to be broken in the Officer's presence, and not weighed or charged, s. 45.

The annealing arches for *Spread or Broad Glass*, *Crown Glass*, *German Sheet Glass*, and *Common Bottles*, are to be constructed with parallel sides, with only one entrance, and to be numbered progressively; s. 46. But the Board may allow any annealing arch for *German Sheet Glass* to be used with two entrances, s. 47. Iron gratings and fastenings are to be provided for the annealing arches and ovens, which are to be locked up when goods are therein, s. 48.; and before heating, *two* hours notice is to be given, s. 49.

All *Crown Glass* as soon as flashed, and *Spread and German Sheet Glass* as soon as opened, is to be placed in the annealing arch, and no other Glass is to be put therein, s. 50. And makers of *Spread*, *Crown*, and *German Sheet Glass*, within half an hour after all the tables or sheets have been placed in the annealing arch, or oven, and before closing up such annealing arch, &c., are to deliver a declaration of the number of tables placed in it, and the number of inches unoccupied between the front table and the grating, (and of each row or pile, 3 & 4 V. c.22, s. 3); and such number of tables or inches is not to be above five per cent, more or less than the true number, under a penalty, s. 51.

All *bottles* and utensils made of common bottle metal are to be placed in the annealing arch as soon as made, in such manner as the officer shall approve of; and no other goods are to be put therein, s. 52; and the maker before beginning to close up the annealing arch, is to deliver a declaration of the number of bottles, &c., placed therein, which number must not differ from the true number by above 5 *per cent*, under a penalty, s. 53.

*Twelve* hour's notice is to be given before beginning to draw *Spread Glass*, *Crown Glass*, *German Sheet Glass*, *or Common Bottles* out of any annealing arch, and the officer is to attend on such notice and unlock the arch, and take an account of and weigh the goods; but no notice is to be given for any other time than between 6 A.M., and 6 P.M., s. 54. As soon as any spread glass, crown glass, or

German sheet glass has been weighed, it must be deposited for *three* hours separate from other glass, unless sooner reweighed by the supervisor, s. 55.

Makers of *German Sheet Glass*, making shades which do not require to be annealed, are to provide a separate room for the deposit of them, s. 56; and after the journey is finished, and before the door of such room is secured by the officer, to declare the number of shades made in each journey, under a penalty, s. 57. The declaration of German sheet glass is not to include cropt cylinders; and no articles to be deemed shades but such as were so before the act, 3 & 4 V. c. 22, s. 4.

The Commissioners may grant permission for *Spread or Crown*, or *German Sheet Glass* to be annealed in a lear, 1 & 2 V. c. 44, s. 58.

*Plate Glass* is not to be manufactured in the same house with *Spread, Crown, or German Sheet Glass*, s. 59. All spread, broad, crown or German sheet glass, of greater thickness than *one-ninth* of an inch, to be forfeited, 3 & 4 V. c. 22, s. 6.

Locks and keys in any glass-house, to be altered and repaired at the trader's expence, 1 & 2 V c. 44, s. 62. Fastenings not to be damaged, or access obtained to places secured under a penalty, s. 63. Proper weights and scales to be provided, s. 64; and the maker with servants, &c., to assist in weighing, s. 65. In weighing glass, the turn of the scale to be given in favour of the Crown; *one* per cent. being allowed in charging the duty, s. 66. Glass not charged, to be kept separate from other glass, s. 67. At the end of every six weeks, the officer is to make a return of the duty, which must be paid in *six* weeks afterwards, s. 68.

For making the charge on *Flint Glass*, an account is to be made out at the end of every six weeks, of the whole quantity charged by guage, and of the whole weight of glass weighed within such period, and two-pence per lb., additional is to be charged on all excess upon the fluxed materials, above *forty* per cent, s. 69.

The fire not to be stirred in any glass house, nor any smoke or vapour raised to prevent the officer from examining pots, metal or glass in the furnace or annealing arch, under a penalty of £100, s. 70. And glass or materials not to be concealed under the penalty of £500, s. 71. Every person making glass, or glass wares, &c., to be deemed a glass maker, s. 72.

*Drop Pinchers*, or makers of beads or buttons from glass, are to make entry of all their rooms or places; and from time to time to produce the invoices of their materials to any officer of Excise, s. 73.

*Flint Glass Makers* are not to open uncoloured shades, except into plates which when opened, are not less than two-tenths of an inch thick, nor greater than 14 inches square, s. 74.

*Glass Benders or Stainers*, not being makers, are to make entry, and not to have shades or cylinders of uncoloured flint glass in their possession, s. 75, and the officers of Excise are empowered to inspect the premises of *drop pinchers, benders and stainers*, s. 76.

The regulations for exporting glass on drawback, are contained in the same act, s. 77—91.

It is the duty of the officers to see that the traders comply with the law in respect to their entries, licences, notices, declarations, weighings, &c.; to guage and calculate the areas and contents of the utensils; to survey and accurately record the state of the house and business at stated periods; to lock up and secure the places and utensils that require it; to weigh and take an account of the glass; and, every round, to make out the required returns for the duty. The duty on flint glass is secured by keeping an officer in constant attendance from the commencement of the journey, until the end thereof. Plate and crown, spread, window, and bottle glass-houses, are required to be surveyed every *six* hours from the time of charging the pots until the metal for each journey is worked out. And glass-houses, in general, where there are fires, but which are not wholly silent, are surveyed twice a day; and if wholly silent, once only.

## Hops.

| 1. *Duties.** | £ | s. | d. |
|---|---|---|---|
| 43 *Geo.* 3, *c.* 69. 45 *Geo.* 3, *c.* 94.—For every pound weight avoirdupois of hops growing or to grow in Great Britain, which shall be cured and made fit for use to be paid by the owners or possessors thereof - - | 0 | 0 | 2 |
| *Treasury Schedule*, dated 18th July, 1823, founded on 4 G. 4, c. 30. For every pound weight avoirdupois of hops of the growth of Ireland which shall be imported from Ireland into Great Britain, to be paid by the importer thereof - - - - | 0 | 0 | 2 |

---

[*] The first duty on Hops was granted by 9 Ann, c. 12, at 1d. per lb. The net revenue arising from this duty in 1829, was £280,080, the whole of which was collected in England.

ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1. From 15th May, 1840, upon the produce and amount of the foregoing duties an additional duty of - - - £5 *per cent.*

### 2. *Drawbacks.*

45 *Geo.* 3, *c.* 99. On the exportation of British hops to the Isle of Man, a drawback of the whole duty paid thereon - - - - - *Whole duty.*

1 & 2 *Geo.* 4. *c.* 100. For every pound weight avoirdupois of hops grown, cured, and made fit for use in Great Britain, and exported as merchandise to foreign parts - - - - - - *Whole duty.*

ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 2. On all drawback due on the exportation or removal to foreign parts, of all such goods and commodities, which shall after Aug. 15, 1840, be so exported or removed, an additional drawback of - - - - £5 *per cent.*

### 3. *Mode of Curing.*

Hops are the fruit of the Hop plant, of which there are extensive plantations in the counties of Kent, Sussex, Surrey, Hertford, and Worcester. They are picked before being ripe enough to shed their seeds, into baskets or bins, from which they are emptied into bags, and conveyed to the oust or kiln to be dried, or stoved. When dry, they are thrown into a chamber where, in a few days, they become so tough from the atmospheric moisture, as to allow of their being, without injury, packed closely in the bags or pockets in which they are sent to market.

### 4 *Regulations for securing the duty.*

Every grower of Hops is required before the 1st of August in each year, to make entry of his Hop grounds; and, before he begins to pick any hops, to make entry of his oust-houses and rooms; 9 Ann, c. 12, s. 6, 7, 8: he is likewise required to give the officer *twenty-four* hours' previous notice in the first week, and forty-eight hours afterwards, of the day and hour when he intends to begin to bag his hops; and a like notice for weighing them, 9 Ann, c. 12, s 10, 11, 12; 6 G. 1, c. 21, s. 25; and 39 & 40 G. 3, c. 81, s. 6.

Before putting Hops into any bag or pocket, the grower is to mark his name, and the parish, &c. thereon, 39 & 40, G. 3, c. 81 s. 2; 48 G. 3, c. 134, s. 1, and 54 G. 3, c. 123, s. 1. All hops are to be cured and bagged within six weeks after having been picked, 9 Ann, c. 12, s. 9.

No officer inferior to a supervisor is allowed to weigh hops between 4 P. M., and 5 A. M., 39 & 40 G. 3, c. 81, s. 7. In weighing the Hops, 10 per cent is deducted from the gross weight for the tare of the package, 9 Ann, c. 12, s. 13. After weighing, the officer is to mark upon each bag and pocket the progressive number, gross weight, and year of charge, s. 4; and the grower is to keep them unmixed with others for *twelve* hours, unless they shall be sooner re-weighed by the Supervisor, s. 5. 8. Hop growers are required to keep just scales and weights, and permit officers to use them, 6 G. 1, c. 21, s. 26.

The weight of hops taken account of by the officer is returned to the Board, and becomes a charge to the grower, 9 Ann, c. 12, s. 11; 6 G. 1, c. 21, s. 28.

The duties are payable, one moiety on the 1st. of March next after the charge; and the remainder on the 1st of October following, 1 and 2 W. 4, c. 53.

A grower is not to use a bag a second time, nor put hops of different qualities into the same bag, or alter them, 7 G. 2, c. 19, s. 2; 54 G. 3, c. 123, s. 2; 9 Ann, c. 12, s. 23; the weight of the bag must be in proportion to the weight of the hops therein, 39 and 40 G. 3, c. 81, s. 3. As to pickers carrying off hops, see 9 Ann, c. 12, s. 18.

Officers are enjoined to visit and survey the grounds and the ousts and kilns under prescribed rules; to see that the hops are removed to the entered ousts to be dried; to attend when notice has been given for bagging hops; and to to take an account of the number of bags and pockets put up; also to attend at the time specified in the notice to weigh the hops for the charge of duty thereon.

As to the removal of British hops to *Ireland*, see 26 G. 3, c. 5.

## Licences.*

See *Auctions, Beer and Cider, Coffee, &c., Glass, Malt, Paper, Passage-Vessels, Post-Horses, Soap, Spirits, Sweets, Tobacco and Snuff, Vinegar, and Wine.* See also p. 286.

---

* The total net revenue arising from the Excise duties on licences in 1839, was as follows: England, £809,732; Scotland, £100,235; Ireland, £122,615.

## Malt.

### 1. *Duties.**

| | £ | s. | d. |
|---|---|---|---|
| 6 *Geo.* 4, *c.* 58. For and upon every 100 gallons imperial standard gallon measure, and so in proportion for any greater or less quantity of malt made in any part of the United Kingdom of Great Britain and Ireland from barley or any other corn or grain, (except malt made for home consumption in Scotland [or Ireland, 11 G. 4, c. 31, s. 1.] from bear or bigg only), or which shall be brought from Scotland into England, without a certificate from the proper officer that it hath paid the full duty hereby imposed, an excise duty of | 1 | 13 | 4 |
| This duty is 2s. 8d. per bushel, but by Treasury warrant dated 11th May, 1826, only 2s. 7d. per bushel is now received. | | | |
| 6 *G.* 4, *c.* 58, (as to Scotland) 11 *G.* 4, *c.* 31, (as to Ireland). For and upon every 100 gallons, imperial standard gallon measure, and so in proportion for any greater or less quantity of malt which shall be made from bear or bigg only in Scotland or Ireland, for consumption in Scotland or Ireland | 1 | 5 | 0 |
| or 2s. per bushel. | | | |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2. Every maltster or maker of malt, within *Great Britain* or *Ireland*, if the quantity of malt made by such maltster or maker of malt within the year ending the 5th day of July in each year shall not exceed 50 quarters, the annual sum of | 0 | 7 | 6 |
| If the same shall exceed 50, and shall not exceed 100 quarters | 0 | 15 | 0 |
| If the same shall exceed 100, and shall not exceed 150 quarters | 1 | 2 | 6 |
| If the same shall exceed 150, and shall not exceed 200 quarters | 1 | 10 | 0 |
| If the same shall exceed 200, and shall not exceed 250 quarters | 1 | 17 | 6 |

---

* A duty on malt was established in England in 1697 (8 & 9 W. 3, c. 22.) in Scotland, 1713, and in Ireland, 1785. The net revenue arising from this duty in 1839, was as follows: England, £4,244,516; Scotland, £362,533; Ireland, £238,899.

| | £ | s. | d. |
|---|---|---|---|
| If the same shall exceed 250, and shall not exceed 300 quarters | 2 | 5 | 0 |
| If the same shall exceed 300, and shall not exceed 350 quarters | 2 | 12 | 6 |
| If the same shall exceed 350, and shall not exceed 400 quarters | 3 | 0 | 0 |
| If the same shall exceed 400, and shall not exceed 450 quarters | 3 | 7 | 6 |
| If the same shall exceed 450, and shall not exceed 500 quarters | 3 | 15 | 0 |
| If the same shall exceed 500, and shall not exceed 550 quarters | 4 | 2 | 6 |
| And if the same shall exceed 550 quarters | 4 | 10 | 0 |
| Every person who shall first become a maltster or maker of malt, on taking out such licence as aforesaid for that purpose, shall pay the sum of seven shillings and sixpence; and, within ten days after the 5th day of July next after taking out such licence, pay such further additional sum as, with the said sum of seven shillings and sixpence, shall amount to the duty herein-before mentioned, according to the quantity of malt made within the preceding year or period for which such licence was granted | 0 | 7 | 6 |
| *Treasury Warrant*, *Dec.* 12, 1826.—Bye-maltsters or persons who make malt for their own use and from the produce of their own premises, not exceeding five quarters yearly | 0 | 2 | 6 |

ADDITIONAL.—3 & 4 *V. c.* 7, *s.* 1. From May 15, 1840. Upon the produce and amount of all the foregoing duties, an additional duty of £5 *per cent.*

## 2. *Drawbacks.*

| | | | |
|---|---|---|---|
| 1 *W.* 4, *c.* 51. For and upon every barrel of thirty-six gallons, and so in proportion for any greater quantity of beer brewed by any entered brewer of beer, for sale in the United Kingdom, and which shall be duly exported to foreign parts as merchandise, in the brewing whereof not less than two bushels of malt shall have been used to every thirty-six gallons of such beer | 0 | 5 | 0 |

£ s. d.

ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 3. Upon any drawback of excise due on goods and commodities entitled to drawback on exportation, and which after 15th Aug. 1840, shall be so exported, an additional drawback of - - - - - £5 *per cent.*

And *see Spirits.*

### 1. *Description of the Process of Malting.*

Malt is grain that has been made to vegetate artificially to a certain extent, after which the process is stopped by the application of heat. Barley is the grain usually employed for making malt, but occasionally wheat, oats, beans, or peas are used; and in Scotland and Ireland an inferior kind of barley called bear or bigg.

The process commences with steeping the corn in a vessel, called a *cistern*, containing cold water, which is sometimes put in before the grain, and sometimes afterwards. The effect of this operation is to cause the grain to increase in bulk and imbibe moisture, whilst at the same time a quantity of carbonic acid gas is emitted, and a part of the substance of the husk is destroyed. In 40 hours, the average swell by steeping is assumed at 18½ bushels for every 81¼ bushels steeped, and this is the rate on which the legal allowances are calculated.

The water is drawn off after the grain has been steeped the required time, which must not be less than forty hours. It is then thrown out of the cistern into an utensil, or a part of the malt house partitioned off, called the *couch frame*, where it forms a heap, usually about sixteen inches deep; and remains not less than twenty-six hours. At the end of that time it is deemed to be a *floor*, and is from time to time turned by means of a wooden shovel, an operation which is called "working on the floor;" and the process goes on as follows:—

1st.—The grain at a certain period (which varies according to circumstances) becomes moist and emits a rather agreeable smell, and soon after this period the roots begin to make their appearance.—2nd.—The *acrospire*, or future stem begins to swell, and gradually advances under the husk, from the same end where the roots are observed to spring, till it nearly reaches the other extremity of the grain. 3rd.—The kernel, as the *acrospire* advances through it, becomes friable and sweet tasted.

The whole art of malting depends upon the proper regulation of these changes. In a day or two after the grain has been thrown out of the cistern (especially if the weather be warm) the roots begin to appear at the end of each kernel in the shape of a small white protuberance, which soon divides itself into distinct fibres or rootlets. The grain about this time appears moist on the outside which is called *sweating*, but which usually goes off in a day or two. If the grain be split and examined in about a day after the spreading of the roots, the acrospire may be seen to be lengthening, and advancing within the husk towards the end of the grain, opposite to that at which it originates. The process of malting however, is brought to a conclusion some time before the stem has made such progress as to burst the husk.

As the germination proceeds the grain is gradually spread thinner on the floor: and when the moisture has been in some degree evaporated, and the germination has thereby been checked, it is again gradually laid thinner to wither. Maltsters however differ much in their manner of working, which is affected, also, by the state of the weather.

The grain having thus germinated to the extent required, it is put upon the kiln and heat applied by means of a fire, which is regulated according to circumstances; and when the malt has attained the requisite state of dryness the process is finished, and the malt is thrown off the kiln. In drying *pale* malt, it is laid thick upon the kiln, and the fire is applied more gradually than for *brown* malt, the colour to which is imparted by a strong fire towards the end of the drying process. And in drying *porter* malt, it is laid quite thin upon the kiln, and while one man keeps turning it, another is applying a strong wood fire to it, which is called "snapping malt," and when it is sufficiently browned, the drying is completed.

### 2. *Regulations for charging and securing the duty.*

Every person making malt, is required to make entry of his rooms, places, and utensils, 7 & 8 G. 4, c. 52, s. 1, and every *cistern* for steeping more than eight bushels at any one time is to be rectangular, and of no greater depth than forty inches, with an even bottom, and no more inclination for the drip than half an inch in each foot; and to be so placed as to be easily and conveniently gauged, 7 & 8 G. 4, c. 52, s. 2, 3; 11 G. 4, c. 17, s. 3; and before being used, a certificate of examination must be obtained from the Supervisor, 7 & 8 G. 4, c. 52, s. 3; and every *couch frame* is to be rectangular, and permanently constructed, 7 & 8 G. 4, c. 52, s. 5.

Every maltster is required to give to the officer, 24 hours' notice of the particular hour when he intends to wet grain, 11 G. 4, c. 17, s. 7, and 1 V. c. 49, s. 2; which must not be at any other time than between 8 A. M. and 2 P. M., 7 & 8 G. 4, c. 52, s. 21; and having begun to wet, he must cover the whole of the grain with water within *three* hours after the time for beginning; and must continue the same so covered *forty* hours; except that, on notice, he may draw off the water, for not exceeding an hour, once in that time; and fresh grain is not to be added after an account has been taken by the officer; 11 G. 4, c. 17, s. 7, 13, 14; 7 & 8 G. 4, c. 52, s. 26.

Corn is not to be taken out of the cistern, so that it cannot be gauged in the couch-frame, under a penalty, s. 31; but must be emptied out between 7 A. M., and 4 P. M. s. 27; and, not before the day on which 96 hours expired from the last preceding emptying, s. 30. And when two or more cisterns are used in the same Malt-house, they must all be emptied within *three* three hours after the emptying begins, s. 29.

Corn emptied from the cistern is to be put into the couch frame, (one such frame being allowed to be used for two or more cisterns in the same malt-house,) but not to be laid deeper than thirty inches, and to be laid flat and level and kept in the couch-frame *twenty-six* hours at least, s. 32; and, if the corn shall not be gauged within that time, any gauge taken before the end of *thirty* hours, is to be deemed a couch-gauge, and such corn not to be entitled to the allowance as a floor-gauge, s. 32; 11 G. 4, c. 17, s. 16

No maltster is to tread or force together any corn in the cistern or couch-frame; and an officer, suspecting it to be so trodden or forced, may have it turned out and returned; and if any increase shall be found in the gauged quantity, after being again laid level, in a greater proportion than five per cent. within *eight* hours, or six per cent. after that time and within *sixteen* hours, or seven per cent. afterwards, a penalty is incurred, 7 & 8 G. 4, c. 52, s. 34; 1 V. c. 49, s. 5.

After corn has been emptied out of the cistern, it is not to be wetted or sprinkled before the end of twelve days, or 288 hours, 7 & 8 G. 4, c. 52, s. 35; unless all the corn on the floor of the malt-house, shall have been steeped fifty hours; in which case a floor may, on notice, be sprinkled at the end of six days, or 144 hours, 1 V. c. 49, s. 7.

No maltster is allowed to have at one time more than six floors, including the couch-frame and kiln, in operation at the same time and worked in the same cistern or couch-frame; but floors may be divided for working separately, 7 & 8 G. 4, c. 52, s. 36; 1 V. c. 49, s. 10. And all floors are to be levelled, and laid in succession according to seniority of age, 11 G. 4, c. 17, s. 19; 7 & 8 G. 4, c. 52, s. 27.

A maltster is not to mix corn of different wettings or steepings, either on the floor or kiln, s. 38; nor to wet or damp corn after being taken off the kiln, s. 39; nor fraudulently to conceal malt, or corn making into malt, from the sight of the officer, s. 40; nor to remove malt before it has been charged with duty; and no person is to receive malt knowing the same to have been so removed, s. 41.

The following allowances are to be made upon the gauges of corn or grain, making into malt, viz: Upon every gauge taken in the cistern, or couch-frame, an allowance of 18½ bushels in every 100; and upon every gauge taken on the floor or kiln, after the expiration of twenty-six hours, if a previous guage has been taken, or thirty hours, if no such previous guage has been taken, an allowance of *one-half*; and the duty is to be charged upon the best gauge after such allowances have been made, 1 V. c. 49, s. 9; and the officer is to make a return of such duty every six weeks, and the same is to be paid and cleared off within six days after the return, unless the maltster shall have entered into bond with sufficient sureties for the due payment of his duties within eighteen weeks after the return, 7 & 8 G. 4, c 52,. 7; 11 G. 4, c. 17, s. 26. But maltsters for distilling from malt only in Scotland and Ireland, are not allowed the long credit whether bond has been given or not, s. 27.

If any maltster's servant shall, with intent to injure his master, commit any offence against the malt acts, he may be arrested, and on conviction committed to gaol; but the maltster is liable to the penalty, unless he prosecute and produce a certificate of conviction, 7 & 8 G. 4, c. 52, s. 46; 11 G. 4, c. 17, s. 35.

In case of loss or damage of malt by fire, or accident, an allowance of the duty is, under certain regulations, made to the proprietor, 7 & 8 G. 4, c. 52, s. 76; 11 G. 4, c. 17, s. 37.

Maltsters are allowed to dry raw grain on a malt kiln, on giving twenty-four hour's notice for the purpose, 11 G. 4, c. 17, s. 2; 2 W. 4, c. 29, s. 14; 1 V. c. 49, s. 2.

The duty of the officer is to keep the traders to a due compliance with the law as regards entries, licences, notices, declarations, &c. He is also to gauge the cisterns, couch-frames and kilns, and enter the dimensions and areas thereof, in the dimension and survey books and specimen.

In residence, maltsters are to be surveyed once every day, and twice when either best cistern or couch gauges are depending, or where fraud is suspected; and in out-walks of divisions, or in one day rides, they are to be surveyed four times a week at least, or nine times a fortnight; and where the circuit is so extensive that it cannot be travelled under two days, thrice every week if possible, or at least, five times a fortnight; care being taken in regulating the intervals between the visits, to fix upon the times best adapted for obtaining the best gauges and detecting fraudulent practices.

At each visit the officer is expected to examine the "house," and to enter in his survey book a correct account thereof, shewing the actual state of every quantity of corn in process of manufacture, whether in the cistern or couch, or on the floor or kiln; and preserving a distinction between each separate wetting or steeping, so that its history from the moment of wetting to that of its being dried off and removed from the kiln, may be readily traced by the entries in the survey books.

As the charge of duty depends upon the officers' gauges, and as the bulk of the corn is continually altering during the malting process, it is evident that great care is necessary in taking such guages, as well as in selecting the proper times for making the surveys. A cistern-gauge should be taken at all maltsters in residence at or near the time specified for beginning to wet, and another, if possible, a short time before the water is drained off. In couch, one gauge should be taken as nearly as possible after the corn is thrown out of the cistern, and another as nearly as possible to the end of twenty-six hours after it is so thrown out. On the floor there should be as many gauges taken as the business of the officer will permit, particularly on young-floors. On each occasion, before gauging, the corn must be made as level as possible; and beside the length and breadth, a sufficient number of depths must be taken, to insure a proper average.

In making his gauges, it is not enough that the officer obtains the actual *quantity* of corn in operation. He ought to make himself so thoroughly acquainted with the practical process of malting as to be able to distinguish the actual state of vegetation or *age* of any of the floors. This can only be attained by observation and experience; but that it is attainable, is proved by the fact, that many and extensive frauds have been brought to light by the judgment of the excise officers alone. Should any discrepancy appear between the state of the corn as shewn in the survey books, and that in the different stages of operation found on survey (which must always be carefully examined,) the supervisor ought to be apprized of it, and proper steps immediately taken for following up the detection.

Fraudulent maltsters have resorted to various artifices at different times for effecting their purposes. In some instances the corn has been found trodden or otherwise pressed together in the cistern or couch-frame; in others, part of the corn in steep, and even a whole steeping has been clandestinely conveyed from the cistern, and either immediately substituted for a floor, or mixed with the depending floors, or otherwise placed in sacks promiscuously among sacks of dry corn, or deposited in some private place, until so far vegetated as to be introduced and mixed with less risk of detection; fresh corn being in such cases, put into the cistern without notice, in the place of the corn removed: and as these frauds are greatly facilitated by sprinkling barley intended to be put in steep, and malt in process of manufacture, upon the working floor, officers are, in various parts of their instructions, directed to be watchful of the conduct of maltsters suspected of any such practices.

The gauges had of each steeping of corn in the respective stages of operation, are to be cast and set forward in the proper columns of the survey book, and the *best* amount according to its relative value, whether arising from the *cistern*, *couch*, or *floor*, is to stand as the charge. And at the close of every round, the respective charges on each maltster are, after being reduced to net bushels, added together, and the duty from the total calculated.

And as noticing the age at which maltsters put their floors upon the kiln to dry, has been found useful in the detection of fraud, (with reference to run wettings,) officers are directed to enter an account thereof on survey, and to transfer the number of floors, and the total of their ages from book to book until the end of the season, when a calculation is made of the average age of the floors at each malt-house. Immediately after the 5th of July, the officer is to deliver to the supervisor a list of the maltsters, the average

age of whose floors at each malt-house for the season exceeds sixteen days, and to add his observations as to the cause thereof. From these lists each supervisor makes out a similar one for his district, and transmits it to the chief office.

A *bye-maltster* is a person who makes only a small quantity of malt for his own private use; has no regular cistern or couch-frame, but steeps the corn in a tub, and couches and works it on the floor of some spare room of his dwelling house or barn; and dries it in an oven, having no kiln for the purpose. Such persons are required to make entry of their places and utensils with the proper officer; but as they frequently reside at a distance from the officer's residence, he is not required to survey them so often as established maltsters: he therefore, after having secured a cistern and couch-gauge on each of their steepings, may, with the permission of his supervisor, be allowed to survey them *once* a week, until the grain is dried off; after which, upon any such trader declaring his intention to make no more malt for the season, and withdrawing his entry, the officer may cease to visit him, except occasionally to satisfy himself that he is not making privately.

Any person who makes malt for sale, (or for his own private use in considerable quantities,) is not to be considered a bye-malster.

*Makers of Malt* in *Scotland* or *Ireland* from *bear* or *bigg* only, are subject to the same regulations, as other maltsters. They are also to express in their entry, that they intend to make malt from *bear* or *bigg* only, 3 G. 4, c. 30, s. 2. And the same premises and utensils are not to be entered for making barley malt, s. 6; but on the contrary, all *bear* and *bigg* malt is to be kept separate from barley malt until it is put into the mash tun; s. 2.

A certificate is to accompany *bear* or *bigg* from the grower to the maltster, s. 7; and when received, it must be kept separate from all other *bear* or *bigg* for twenty-four hours, s. 9; and must not be steeped during that time, or until it has been examined by the officer, s. 10, who is authorized to take samples, s. 11.

These regulations are extended to *Ireland* as well as *Scotland*, by 11 G. 4, c. 31.

For the regulations under which beer is exported on drawback. See 1 W. 4, c. 51; and as to private malting in Scotland and Ireland, see 1 & 2 W. 4, c. 55.

**Mixtures.**—See *Spirits*.

## Paper.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 2 *&* 3 *V. c.* 23, *s.* 1.—On every pound weight avoirdupois of all paper, glazed paper, sheathing-paper, button-paper, or by whatsoever name any paper may be known, and on all button-board, mill-board, paste-board, and scale-board, made in the United Kingdom, a duty of | 0 | 0 | 1½ |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every maker of Paper, Pasteboard, or Scaleboard, in *Great Britain* or *Ireland*, [except makers of scaleboard from wood, repealed by 4 and 5 W. 4, c. 77,] the annual sum of - - | 4 | 0 | 0 |
| ADDITIONAL.—3 *&* 4 *V. c.* 17, *s.* 3.—From 15th May, 1840. Upon the produce and amount of all the foregoing duties, an additional duty of - - | £5 *per cent.* | | |

### 2. *Allowances.*

| | £ | s. | d. |
|---|---|---|---|
| 2 *&* 3 *V. c.* 23, *s.* 1.—For all such Glazed or other Press Papers, made and charged with duty in the United Kingdom, for Clothiers and Hot pressers, as shall be actually and *bonâ fide* used, employed, and consumed in the pressing Woollen Cloths and Stuffs in the United Kingdom, an allowance per lb. avoirdupois | 0 | 0 | 1½ |
| For all Paper made and charged with duty in the United Kingdom which shall be used in the printing of any books in the Latin, Greek, Oriental, or Northern Languages within the Universities of *Oxford* and *Cambridge*, or within the Universities of *Scotland*, or the College of the Holy and Undivided Trinity of Queen Elizabeth, *Dublin*, by permission of the Vice Chancellors, Rectors, or Principals or Provost of the said Universities respectively, or which shall be used in the printing of Bibles, Testaments, Psalm Books, Books of Common Prayer of the Church of *England*, the book commonly called or known in *Scotland* by the name of "The Confession of Faith," or the larger or shorter Catechism of the Church of *Scotland*, within | | | |

---

[*] The Excise duty on paper was first imposed in Great Britain, by 10 Ann, c. 19, and in Ireland, by 38 G. 3, c. 5. The net receipts arising from this duty in 1839, (exclusive of licences), were as follows: England, £490,702; Scotland, £113,315; Ireland, £23,118.

| | £ | s. | d. |
|---|---|---|---|
| the Universities of *Oxford* and *Cambridge*, and Trinity College, *Dublin*, by permission of the Vice Chancellors or Provost of the same, or by the Queen's Printers in *England*, *Scotland*, and *Ireland* respectively, an allowance per pound avoirdupois - - - | 0 | 0 | 1½ |

### 3. *Drawbacks.*

| | | | |
|---|---|---|---|
| 2 & 3 *V. c.* 23, *s.* 1.—For every pound-weight avoirdupois of all paper, sheathing paper, button paper, button board, mill-board, paste-board, and scale-board, made and charged with duty in the United Kingdom, and which shall be duly exported as merchandize, a drawback of - - - - - - | 0 | 0 | 1½ |
| For every pound weight avoirdupois of printed books in perfect and complete sets, or if periodical publications, in perfect parts or numbers, and of blank, plain, or ruled account books, whether bound or unbound, made of or printed or ruled on paper made and charged with duty in the United Kingdom, and which shall be be exported as merchandize, a drawback of - - | 0 | 0 | 1½ |
| For every dozen square yards of paper made and charged with duty, and printed, painted, or stained, in the United Kingdom, and exported as merchandize, a drawback of - - - - - - | 0 | 0 | 2 |

ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 3.—Upon any drawback of excise due on goods and commodities, entitled to drawback on exportation, and which after Aug. 15, 1840, shall be so exported an additional drawback of £5 *per cent.*

### 4. *Process of Manufacture.*

Linen and Cotton rags are the common materials of which the finer papers are made; but hemp, old rope and other substances, as straw, &c., are used for the coarser kinds. These materials after being washed, are immersed in water in the engine, and subjected to the action of a revolving cylinder, in the surface of which are inserted a number of sharp iron plates or cutters, all so placed as to act against other cutters fixed in the bottom of the engine underneath the cylinder, which is very rapidly turned by machinery, usually from the outside by a water-wheel, and the rags, from the motion of the cylinder and the current occasioned thereby, are repeatedly drawn between the iron plates or bars of the engine, and are by that means, ground or beaten to a pulp. During the process, for the finer papers, a quantity of chloride is mixed with the materials for bleaching or whitening them. The pulp is afterwards put into a large vessel called a "stuff chest," from whence it is taken as it is wanted into a vat, and mixed with a sufficient quantity of water, and kept in a lukewarm state, ready for the mould.

Paper is made either by hand or by machinery. For the former process, moulds of the size of the paper intended to be made, with bottoms of brass-wire, something like a sieve, are dipped into the vat, and the pulp in a fluid state, is taken up and gently shaken by the workman, so as to leave the pulp when the water is drained off, equally spread over the surface of the wire. It is then, gently turned upon a woollen cloth called a felt, and thus becomes a sheet of paper. On this sheet another felt is laid, and another sheet upon that, and so on, alternately till a heap is raised, called a "post." The whole is then put into a press, and, after the water is squeezed out, the sheets are separated from the felts, and laid one upon another, and again pressed, and afterwards hung in parcels, called "spurs," of three, four or five sheets in each parcel, upon lines, called "trebles" in the drying houses. The paper is next counted into quires, and after being pressed, is tied up in reams, half reams, or parcels; and enclosed in the required wrappers for being weighed and charged with duty.

Brown, whited-brown, and other coarse papers, not requiring to be sized, are sooner dried and finished.

When paper is made by machinery, the pulp is discharged or run from the vat upon a brass wire web, revolving upon cylinders, by which the paper can be made of almost any length. As it is made, it is passed between hot iron cylinders to dry, and wound off upon a reel, placed at the lower end of the machine, and moving in nice accordance with the machine, as the web of paper is formed and moves onward; and when the reel is sufficiently full, the paper is cut upon it into sheets of the size required.

Mill-board, (except very thick,) button-board, button-paper, glazed-paper, and sheathing-paper, are made after the same manner, differing however, in the sheets being made thicker, either by repeated dips in the vats, or by laying two or more sheets, one upon another, on their being turned out of the mould, and pressing them together whilst in a wet state; and, in putting up, the sheets are not folded, but spread, and severally tied up in parcels of even dozens.

Very thick mill-board is made in a frame with a press to it, the pulp being taken up in a hand-bowl, and spread to the required thickness in the frame, when the press is applied to squeeze out the water, and the sheet is formed.

### 5. *Regulations for securing the Duty.*

Every maker of paper, &c., is to make entry of his premises and utensils, which are to be marked with particular letters, 2 & 3 V. c. 23, s. 3, 4. Every paper-mill is to be distinguished in the Officer's books by a particular number, s. 5. Two mills not further apart than a mile, when the paper is removed from one to the other to be finished, may, with the Board's permission, be worked as one mill, under one entry, and one licence, s. 6. The Officers of Excise are to be at liberty to survey the premises, s. 7.

The Commissioners of Excise are to provide stamps for denoting the charge of duty, s. 8. They are also to issue paper labels, to the Supervisors; and the trader is to be supplied with such labels within four days after delivering to the officer, a request note, upon which a receipt is to be given for the same; and such labels are to be delivered up at any time to any supervisor or superior officer, s. 9.

All paper, &c., to be made up into reams, half reams or parcels, and to be enclosed in wrappers with a label firmly fixed on the top or such other part thereof as the Board shall direct, and then secured with a string; and when tied up, the maker is to mark on the label the description and contents of the ream, &c., s. 10. A ream is to consist of 20 quires of 24 sheets each, or 40 half quires; and a half ream of 10 quires or 20 half-quires; except that for printing, the ream may be 516 sheets, and the half ream 258 sheets; and except the outside quires of any ream which may be from 20 to 24 sheets. A parcel of glazed paper, &c., to consist of even dozens not less than 24, nor more than 72 sheets in each, s. 11. But parcels less than a ream of paper not weighing less than 20lbs. may be made up, if necessary, on the number of sheets being marked on the label, s. 12.

Any Paper-makers before tying up paper, &c., may cut the edges and make it up into quires without folding, provided every quire be separated by a slip of coloured paper, s. 13.

The weight of every ream, half-ream, or parcel of paper or mill-board, &c., is to be written thereon, s. 14.

Twenty-four hours' notice in a town, and forty-eight hours elsewhere, to be given of the maker's intention to weigh his paper, s. 15. At the time specified in the notice, the proper officer is to attend and weigh the paper, and charge and stamp it, s. 16.

Under certain regulations, paper may be sent out in single sheets on the rollers, on which the same may be received from the machine without, cutting or making up, s. 17.

Paper, &c. after being weighed, to be kept separate for twenty-four hours, unless sooner reweighed, s. 18. If the paper-maker, shall desire paper, &c., not to be reweighed on a Sunday, it may be kept over until Monday, s. 19. The maker to keep just scales and weights, and allow the officer to use them, s. 20. And the maker when required, is to bring the paper to be weighed, and assist the officer in weighing, s. 21. In weighing for charge of duty, the turn of the scale to be given in favour of the Crown, and in lieu thereof *two per cent.* to be allowed to the traders, s. 22. Paper, &c. not charged, to be kept separate from charged paper, s. 23. And reams, &c. after being tied up not to be opened or altered, s. 24.

An account of paper, &c. sent out from the mill, to be daily entered in a book by the maker, and such book to be open to the inspection of the officers, s. 25. Any ream, half ream or parcel, sent out without being tied up and labelled, to be forfeited, s. 26. Paper found different from the weight marked on the ream, half-realm, or parcel, by 5 *per cent.*, if above 20lbs., or by 10 *per cent.*, if under to be also forfeited, s. 27. And any maker sending out paper, &c., before the duty is charged, to forfeit £300, s. 28.

Paper may be removed from one mill to another, to be sized and finished on notice and certificate, s. 29. And paper charged with duty at another mill, or returned from a customer, to be marked, returned and notified by the officer, s. 30.

Makers of *paste-board* not being paper-makers, to use duty charged paper only, s. 31 ; and to produce to the officer all paper before making use of it, in order to its being taken account of, s. 32.

Every maker, or his chief workman, to make a declaration every six weeks, that no other than duty charged paper has been sent out of the mill, s. 33. And at the end of every six weeks the officer is to make a return of the duty charged on every maker, and the amount to be paid in six days afterwards, s. 34.

In making up the charge against a *paste-board* maker not being also a maker of paper, the duty charged on the paper used therein is to be deducted, s. 35.

No person to carry on the business of a *stationer* at any mill, nor any maker to be a stationer within a mile of his mill, s. 36.

*Stationers, Printers, Paper-Stainers, and Makers of Pasteboard,* are prohibited from receiving paper in less quantities than in an entire ream, half-ream or parcel, and inclosed in legal wrappers; and no other person is to remove or receive it from a mill in less quantities than as aforesaid, s. 37. Every person on opening paper is to write across or otherwise deface the label, s. 38. And labels or wrappers which have been used, are not to be returned to, or received back at a mill, s. 39; unless the paper be returned for not being approved of, s. 40. But any stationer, &c. having paper liable to seizure and giving notice thereof to an excise officer, so as to cause its seizure, is, on its condemnation, to be paid the value thereof, s. 41.

Any person forging stamps, or counterfeiting labels, &c., to forfeit £500, for every ream, &c. which is forfeited, s. 42; and any person altering the number of the mill or weight on the label, to forfeit £20 per ream, &c., s. 43.

The regulations for obtaining the allowances and drawbacks granted in respect of paper, are contained in the same act, s. 44 to 64.

"Paper," except when otherwise expressed, is to include glazed paper, sheathing paper, button paper, &c., s. 65, 66.

It is the duty of officers to see that paper makers, &c., comply with the law in respect to their entries, licences, notices, declarations, labels, weighing, &c. They are required to survey papermakers, &c. in the residence of any station once a day, (Sundays excepted); those in the country business of any division, or one-day ride, four times a week; and those in the country business of a two-day ride, or more, five times a fortnight, at least; and so that there be never above three days' interval between the visits. The particulars of all surveys are to be entered in the specimen paper kept on the entered premises, as also in the survey book; and on every survey, the premises are to be inspected with great circumspection and care.

## Passage-Vessels.

### 1. *Duties.*

| | £ | s. | d. |
|---|---|---|---|
| 9 *Geo.* 4, *c.* 47—For every licence to any master or commander of any packet boat or other vessel employed for the carriage and conveyance of passengers from | | | |

| | £ | s. | d. |
|---|---|---|---|
| one part of the United Kingdom to another, or other part thereof, or to any other person belonging to any such packet boat or vessel who shall be nominated and approved of by the owner or owners, or director or directors thereof residing in England, Scotland, or Ireland respectively, to provide for and supply, retail, and sell to the passengers on board such vessel, to be consumed by them in and on board thereof during the voyage on which such passengers shall then be carried or conveyed, foreign wine, strong beer, cider, perry, spirituous liquors, and tobacco - - - | 1 | 0 | 0 |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1.—From May 15, 1840, upon the produce and amount of the foregoing duty, an additional duty of - - - | £5 *per cent.* | | |

## Pepper.

See *Coffee, Tea, Cocoa-Nuts, Chocolate and Pepper.*

## Post-Horses.

### 1. *Duties.**

| | £ | s. | d. |
|---|---|---|---|
| 2 & 3 *W.* 4, *c.* 120. Sch. A.—For and in respect of every horse let for hire by the mile at the usual rate charged for horses travelling post at the place at which such horse shall be let for hire; (that is to say,) for every mile such horse shall be hired or used to travel or go - - - - - | 0 | 0 | 1½ |
| And for and in respect of every horse let for hire, to go no greater distance than eight miles from the place of letting; one fifth part of the sum charged for such letting or in lieu thereof, at the option of the person letting the horse - - - - | 0 | 1 | 9 |
| And for and in respect of every horse let for hire, to go no greater distance than eight miles from the place of letting, where such horse shall not bring back any person, and shall not deviate from the usual line of road between the place of letting and the place to which such horse shall be hired to travel or go - | 0 | 1 | 0 |

---

[*] The Post Horse duties were transferred from the stamp office to the excise, by 6 & 7 W. 4, c. 45. The net revenue arising from these duties in 1839, exclusive of licences was in England, £205,499, and in Scotland, £18,853.

| | £ | s. | d. |
|---|---|---|---|
| And for and in respect of every horse let for hire, or used for any period of time less than twenty-eight successive days, or in any other manner than as aforesaid - - - | One-fifth part of the sum charged or received, or agreed to be received on every such letting for hire or using. | | |
| And also for and in respect of every horse let for hire, for twenty-eight successive days, or for any longer period of time, where any such horse shall be returned in a less period of time than twenty-eight successive days; and shall not be exchanged for another horse in continuation of the same hiring. | | | |
| Or in lieu of such last-mentioned one-fifth part of such sum (at the option of the person letting the horse) the following duties for every day such horse shall be let for hire or used, or (shall by virtue of any such letting) have been under the direction of the person to whom the same shall be hired (that is to say) | | | |
| For every day not exceeding three days - - | 0 | 2 | 6 |
| And for every day exceeding three days and not exceeding thirteen days - - - - - | 0 | 1 | 9 |
| And for every day exceeding thirteen days and less than twenty-eight days - - - - - | 0 | 1 | 3 |
| COMPOSITION.—2 & 3 *W.* 4, *c.* 120, *s.* 84.—For all or any horses used for drawing every carriage when drawn by two horses, per week* - - - - | 0 | 5 | 0 |
| And for any horse or horses used for drawing every carriage when drawn by one horse, per week - - | 0 | 3 | 0 |
| LICENCES.—2 & 3 *W.* 4, *c.* 120, Sch.—For and in respect of every licence to be taken out yearly, by every person who shall let any horse for hire in Great Britain - - - - - - - | 0 | 7 | 6 |

### 2. *Regulations for securing the Duty.*

Postmasters are to have the words "*licenced to let horses for hire,*" painted on a sign board, 2 & 3 W. 4, c. 120, s. 59. Their licences are to expire on 31st Jan. annually, s. 55; and may be acted on by representatives thirty days in case of death, &c., s. 56; but one licence will only serve for one place, s. 58.

---

* Such carriages must be regularly and constantly used for plying for hire in the public streets of some city, town or place, *other than London*, and must not go any greater distance than five miles from the General

The Commissioners, or their Officers, are to supply Post-masters and Toll-Gate Keepers with proper tickets, s. 61; and every Postmaster who shall let any horse for hire, is to deliver a ticket properly filled up to the hirer, under a penalty, s. 62. No person to pay hire for more miles than is expressed in the ticket, s. 63. Persons using hired horses to deliver the tickets at the first toll-gate, and to receive check tickets, s. 64. The toll-gate keepers are to demand the tickets, and deliver the check tickets; and 1s. 9d. to be paid to the toll-gate keepers on passing without producing the proper ticket, s. 65. Penalty on neglecting to deliver tickets, or falsely alleging hired horses to be their own s. 66. The toll-gate keepers are to deliver the tickets received by them, to the proper Collectors, s. 67, for which they are to receive an allowance, s. 68.

The Commissioners may erect gates in certain cases for the receipt of tickets, s. 69.

When horses hired for 28 days or more, are returned within that period, the check ticket to be delivered up to the Collector s. 70.

Postmasters are to account for tickets delivered to them, and to pay one shilling per horse for every missing ticket, s. 71. Penalty on forging tickets, £50, s. 72.

The Commissioners are to deliver to licensed Postmasters, forms of "Weekly Accounts," s. 73, in which an account of each hiring is to be inserted, s. 74. Entries are to be made on the day the horses are let, s. 75. The account is to be kept open for inspection, s. 76. At the time fixed in the notices for that purpose inserted in the "Weekly Accounts," Post-masters are to deliver their accounts and pay the duty s. 77, 82. The Postmaster to make a declaration to the truth of his account, s. 78. An allowance to be made to the Postmasters of 3d. in the pound, s. 80.

Penalty on Postmaster for wilful fraud, s. 81.

It is the duty of the officers to keep the traders to a due compliance with the law, as regards licences, tickets, weekly accounts, declarations, &c. In residence, Post-Masters are to be surveyed at least, three times a week, and toll-gates once a day; and in ride or country business, (except under certain circumstances), both are to be surveyed the same as growing duty traders.

---

Post Office in such city, town or place, and must be numbered, and have the owner's christian and surname, and the name of the city, town or place, painted or inscribed upon the outside of each door, or upon some conspicuous part of such carriage, 2 & 3 W. 4, c. 120, s. 84.

## Soap.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 3 *&* 4 *V.*, *c.* 49, *s.* 1.—For every pound weight avoirdupois of all hard soap, which shall be made in Great Britain, to be paid by the maker thereof, a duty of | 0 | 0 | 1½ |
| For every pound weight avoirdupois of all hard soap which shall be brought from Ireland into Great Britain, to be paid by the importer thereof a duty of - - | 0 | 0 | 1½ |
| For every pound like weight of all soft soap which shall be made in Great Britain or which shall be brought from Ireland into Great Britain, to be paid by the maker or importer thereof respectively, a duty of - | 0 | 0 | 1 |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every maker of soap for sale within Great Britain or Ireland, the annual sum of - - - - - - | 4 | 0 | 0 |
| ADDITIONAL.—3 *&* 4 *V. c.* 17, *s.* 1. From 15th of May, 1840, upon the produce and amount of all the foregoing duties an additional duty of - - | £5 *per cent.* | | |

### 2. *Drawbacks.*

| | | | |
|---|---|---|---|
| 3 *&* 4 *V. c.* 49. For every pound weight avoirdupois of all hard soap, for which the duty in respect thereof shall have been paid or charged, and which shall be duly exported as merchandize from Great Britain to foreign parts, or which shall be shipped as stores of any vessel entitled to ship stores duty-free, or which shall be removed from Great Britain into Ireland, a drawback of - - - - - - | 0 | 0 | 1½ |
| For every pound weight avoirdupois of all soft soap which shall be so exported, shipped or removed, a drawback of - - - - - - - | 0 | 0 | 1 |
| ADDITIONAL.—3 *&* 4 *V.*, *c.* 17, *s.* 2. From 15th of Aug., 1840, upon all the foregoing drawbacks, an additional drawback of - - - - | £5 *per cent.* | | |

### 3. *Allowances.*

3 *W.* 4. *c.* 16. On all soap used, employed, or consumed in Great Britain in the making of any cloths, serges,

---

[*] The duty of Excise was first imposed on Soap by 10 Ann. c. 19. The net revenue arising from it in 1839, exclusive of licences, was in England £700,650; and in Scotland, £82,284.

kerseys, bays, stockings, or other manufactures of sheep or lamb's wool only, or manufactures whereof the greatest part of the value of the materials shall be wool, or in the finishing of the said manufactures, or preparing the wool for the same, or in the whitening of new linen in the piece for sale, or in preparing and finishing any manufactures from flax or cotton for sale, or in the process of throwing, printing, or dyeing of silks, one half of the respective allowances payable on soap used for such purposes, before 1st June, 1833, viz.:

| | | £ | s. | d. |
|---|---|---|---|---|
| Silk, linen, flax, or cotton - - | Hard soap | 0 | 0 | 1½ |
| | Soft soap | 0 | 0 | 0⅞ |
| Wool - - - - - - | Hard soap | 0 | 0 | 1⅛ |
| | Soft soap | 0 | 0 | 0½ |

These allowances are by 2 & 3 *V. c.* 33, to continue until the end of the Session of Parliament next after May 1841.

### 4. *Process of Manufacture.*

*Hard Soap,* in Great Britain, is made by mixing tallow, or some other oily acid, with a solution of caustic soda in an iron pan, and boiling the mixture till it is converted into soap. A quantity of common salt is then thrown into the pan, which dissolving in the water, displaces the soap and causes it to float on the surface. The fire is then extinguished, and after an interval of one or more days, the liquid soap is put into frames, where it is left till it has become cold and solid; it is then cut into wedges for sale. The price of tallow being much higher than that of common rosin, the manufacturers are in the habit of substituting a portion of this last article instead of tallow. Soap made of soda and tallow only, is *white* soap. If rosin is added, it constitutes *yellow* soap. Pretty generally a portion of palm oil is added to yellow soap, which deepens the colour, giving it a tint of red. The soap called "*mottled*" obtains its marble-like stain by dispersing the lees through it towards the end of the operation.

Most soap makers in Scotland, and many in England employ *kelp* to furnish the requisite quantity of soda, and others employ an impure anhydrous carbonate of soda, called soda ash.

*Silica Soap,* contains a portion of calcined flints reduced to a fine powder; and *clay* soap contains a portion of white clay made into thin paste with water; the silica or clay, as the case may be, being either mixed with other materials in the pan, or mixed, or "crutched" in the frames.

*Soft Soap* is usually made from fish oil and potash lees; the lees not being drawn off in the operation, but combining with, and remaining in the oil.

### 5. *Regulations for securing the duty.*

Every soap maker is to make entry of his premises and utensils, 3 & 4 V. c. 49, s. 3; and to mark and number the same, s. 4. The excise officers are empowered to enter and survey, s. 5; and the soap maker, if required, is to provide sheds or watch-boxes for their accommodation, s. 6. Every soap maker is also required to provide covers for his coppers and half-boil tubs, s. 7; and proper fastenings for securing the covers of his coppers, tubs and vessels, which are to be kept under the officers' lock when not in use, s. 8. Coppers are not to have pipes or holes therein, s. 9; unless the soap be boiled by steam, in which case one continuous pipe may be used. s. 10.

*Six* hours notice is to be given for unlocking coppers, between 6 A. M., and 6 P. M., and twelve hours for unlocking coppers at any other time; which notice is to be void, if not acted on within three hours of the time therein specified, s. 11; but the officer may open and inspect at any time, s. 12.

Soap, &c. may be removed from one copper, &c. to another, for the purpose of repairs, under certain restrictions, s. 13; and materials may be removed from one copper to another in the officer's presence, a proper notice being first given, s. 14; and in case of accident, the materials may be removed on an immediate notice, s. 15.

A supervisor or surveyor may direct a copper to be cleaned out for examination after a cleanse, s. 16.

Covers, fastenings, locks and keys to be altered and repaired, when required, at the expence of the soap-maker, s. 17, and penalties are incurred if access be gained to the coppers when secured, or if the fastenings are damaged, s. 18.

*Six* hour's notice is to be given of cleansing soap, s. 19; and none to be cleansed between 7. P. M. in summer, or 8 P. M. in winter, and 6 in the following morning, s. 20. The frames for cleansing soap, (except any in use before the passing of the act), to be made of wood, iron, or slate; and to be of a rectangular shape, 45 inches long, and 15 broad, and of proper strength and thickness, s. 21. No frame to be made use of until the dimensions have been ascertained by the officers, and not afterwards to be altered, s. 22. No intermediate vessel to be used except pails, or a pan capable of containing an entire frame, s. 23.

*Hard Soap* to be cleansed to not less than the depth of 45 inches in the frame, s. 24; and where the cleanse shall not exceed three tons, the whole to be put into the frames in two hours; not exceeding six tons in three hours; and exceeding six tons then within twenty minutes for each additional ton cleansed, s. 25. When after a cleanse, any foul goods shall be left in the copper; the soapmaker is to return all the fob and skimmings, and add fresh materials, s. 26.

All hard soap to be charged with duty by gauge, s. 27; and in gauging hard soap from the usual materials, 28 cubic inches, when hot, and 27·14, when cold, to be taken as a pound weight avoirdupois, s. 28. But in charging *mottled* soap one lb. in ten, to be allowed, s. 29; provided such mottled soap be made of the usual materials, and cleansed within a given time, s 30. And when soap is made in a high pressure boiler, and not fitted, 26·76 cubic inches when hot, and 25·91 cubic inches when cold, to be a pound avoirdupois, s. 31. When earth or other materials are used in making hard soap 24·04 cubic inches when hot, and 23·30 cubic inches when cold, to be a pound avoirdupois, s. 32.

The Soap maker is to deliver a declaration, whether the soap to be cleansed, is made from ordinary materials, or has had earthy matter added to it, s. 33. And officers may take samples of the soap when cutting up, on paying for the same; and if within 48 hours it be found of a greater specific gravity than 1·05, or (if boiled in a high pressure boiler and not fitted,) than 1·08 (water being taken at unity, at a temperature of 62°,) to be deemed to be mixed with earthy matter, s. 34.

Hard soap, if of the depth of 50 inches or less, to be cut up and removed within *six* days from a wooden frame, and within four days from an iron or slate frame. If deeper than fifty inches within seven days from a wooden frame, and within five days from an iron or slate frame (Sunday's exclusive), s. 35. And after the soap has been cut up, the scraps and parings to be returned into the copper, s. 36.

Hard soap not to be sold or sent out in any other form than bars or parts of bars, s. 37.

*Soft Soap* to be cleansed only into barrels, (256 lbs.) half-barrels, (128 lbs.); firkins (64 lbs.), or half-firkins, (32 lbs.); *s.* 38, and at the time of cleansing, the maker is to produce all the barrels, firkins, &c. properly tared, s. 39. When a soft-soap boiler shall contain less than 2,560 lbs. weight, the whole to be cleansed within an hour; when less than 5,120 lbs. weight, within two hours; and when 5,120 lbs. weight or more, within three hours, s. 40. Soft soap to be weighed for the charge of duty within three days (Sunday exclusive) after being cleansed, and to be adjusted in the barrels, &c., s. 41. A Supervisor or Surveyor may reweigh at any time, s. 42; and makers of soft soap are to provide scales and weights, and assist the officers in using them, s. 43.

The officers are to make a return of the duty charged on each soap-maker weekly, or as the commissioners shall appoint; which duty is to be paid within *six* days afterwards, under the penalty of double duty, s. 44.

Penalty on mixing water, &c. with soap after being charged, s. 45, and for concealing soap and materials, s. 46.

The Commissioners may allow experiments to be made in the process of making soap, under certain regulations, s. 47; and may also allow the use of new or improved utensils, although not made in conformity with the act, s. 48.

Soap-makers are not to work on Sundays, except in cases specially provided for, s. 49.

Officers may break up ground to search for private pipes and conveyances, s. 50.

Every person making or melting soap to be deemed a soap-maker, except certain perfumers, s. 51.

*Perfumers* to make entry with the excise, s. 52. *Candle-Makers*, and tallow-melters are also to make entry, and not to have alkaline lees in their possession, s. 53; and *lees* fit for soap-making not to be manufactured for sale, s. 54.

Entry to be made with the excise officers, of soap brought from Ireland, s. 55, which must not be in packages less than 224 lbs each, s. 56.

The regulations respecting entering and shipping soap on drawback, are likewise contained in the same act, s. 57—68.

The regulations for allowing the duty on soap used in manufacturing cloths, &c., are contained in 23 G. 3, c. 77; 3 G. 4, c. 25, (made perpetual by 7 G. 4, c. 49,) 7 G. 4, c. 53, s. 4, and 3 W. 4, c. 16, s. 9.

The duty of the officer is to keep the traders to a due compliance with the law, as regards entries, licences, notices, declarations, &c. He is also to gauge the coppers for soft soap, and the frames for hard-soap, and enter the dimensions and are as thereof in the dimension book and survey book.

In residence, soap-makers are to be surveyed at least, once in *six* hours when at work on the first boil, or when boiling materials for foul goods; and afterwards officers are not to be more than *four* hours wide in their visits; and when there is any frame-guage of soap depending *thrice every* day, (except Sundays); and when silent *twice*. Out of residence, soap-makers are to be surveyed at least, *five* times a fortnight, and at uncertain intervals, so as not to be more than *three* days between each visit; care being taken, in regulating the intervals between the visits,to fix upon the times best adapted for obtaining the most correct gauges, and detecting fraudulent practices.

At large establishments, and where a trader works in the night, or keeps his soap an unusual time in operation, an assistant is employed, and his duty is to remain on the premises (in conjunction with the surveying officer) all the time that any copper is open for working.

The only account taken of hard-soap, is by gauge, during the time it is in the frames. The chief object of the officer's survey therefore, is to ascertain that all the soap is duly conveyed out of the copper into the frames, and then to obtain the earliest and most correct account of the quantity cleansed. For this purpose he is frequently to examine the state of the materials or soap in the copper, or frames; to compare the same with the state of such materials or soap as found on former surveys; to see that the coppers are carefully locked and secured with proper labels when not open under regular notice; frequently to examine the state of the copper covers and fastenings; always to be present if possible when the soap is cleansed out of the copper into the frames; and immediately, or as soon afterwards as possible, to gauge the soap in the frames; and to continue to gauge it on every survey afterwards until it is entirely cut up and removed; carefully entering an account of his surveys and gauges in his survey book.

With regard to *soft soap*, the officer is required on his first survey after a boil, to take a gauge in the copper or boiler, in order to compare the quantity then found, with the quantity cleansed and produced for charge; and before cleansing, he is to weigh and tare each of the casks, and to mark the tare on its side. He is to attend at the time the soap is cleansed from the copper; and take account of the number of barrels, half-barrels, firkins, and half-firkins filled with it; and enter the same in his survey book, noticing to his supervisor any material desparity that may appear.

### Spirits.

| 1. *Duties.*[*] | £ | s. | d. |
|---|---|---|---|
| ENGLAND.—6 *G.* 4, *c.* 80. For and upon every 100 gallons imperial standard gallon measure of spirits of the strength of hydrometer proof, as denoted by the hydrometer called Sikes's hydrometer, which shall be made or distilled in England by any person or persons whomsoever the sum of thirty-five pounds, and so in proportion for any greater or less degree of strength, and for any greater or less quantity, to be paid by the first maker or distiller of such spirits (*being per gal.*) | 0 | 7 | 0 |
| 1 *W.* 4, *c.* 49.—For and upon every gallon of spirits of the strength of hydrometer proof, ascertained by the hydrometer called Sikes's hydrometer, which shall be made or distilled in England by any person or persons whomsoever, an additional duty of sixpence, and so in proportion, &c. (*as above*) - - - | 0 | 0 | 6 |
| 3 *&* 4 *V.* *c.* 17, *s.* 3.—Upon every gallon of spirits of the strength of hydrometer proof, which shall be distilled in England, an additional duty of - - | 0 | 0 | 4 |
| The additional duties were also charged on stock in hand. | | | |
| SCOTLAND.—6 *G.* 4. *c.* 58. For and upon every 100 gallons imperial standard gallon measure, and so in proportion for any greater or less quantity of spirits of the strength of hydrometer proof, and so in proportion for any greater or less degree of strength made or distilled in any part of Scotland from any wort or wash brewed or made from malt, or from corn or grain, malted or unmalted, or any mixture thereof, or from sugar, or from potatoes, by any person or persons whomsoever, or for which any distiller shall be chargeable, 14l. 3s. 4d. (*being per gallon*) - - - | 0 | 2 | 10 |

---

[*] The duty on spirits was one of the first, and has always been considered one of the most important of the excise duties. See p. 279. .The net revenue arising from this duty in 1832, (exclusive of licences) was as follow :—England, £2,552,624 ; Scotland, £1,487,814 ; Ireland, £1,402,040. Formerly there was an excise duty on spirits imported from abroad, but this duty has been transferred to the customs.

| | | | |
|---|---|---|---|
| 1 *W.* 4, *c.* 49. For and upon every gallon of spirits of such strength as aforesaid (viz. hydrometer proof) which shall be made in Scotland, an additional duty of | 0 | 0 | 2 |
| For and upon every gallon of spirits of such strength as aforesaid, which shall be made or distilled in Scotland, a further additional duty of - - - | 0 | 0 | 4 |
| over and above the said additional duty of twopence, and so in proportion for any greater or less degree of strength, or any greater or less quantity. | | | |
| 3 *&* 4 *V. c.* 17, *s.* 3. Upon every gallon of spirits of the strength of hydrometer proof, which shall be distilled in Scotland, an additional duty of - - - | 0 | 0 | 4 |
| The additional duties were also charged on stock in hand. | | | |
| 6 *G.* 4, *c.* 80. For and upon every hundred gallons of spirits of such strength as aforesaid, which shall have been or shall be made and extracted in Scotland, and warehoused there without payment of duty, and which shall be taken out of the warehouse there for the purpose of being brought or imported into England for consumption, the sum of thirty-five pounds, and so in proportion for any greater or less degree of strength, or any greater or less quantity, to be paid by the distiller or proprietor thereof at the time of the delivery of such spirits from the warehouse in Scotland for the purpose of being brought or imported into England (*being per gallon*) - - - - - | 0 | 7 | 0 |
| 1 *W.* 4, *c.* 49. For and upon every gallon of spirits of such strength as aforesaid which shall have been or shall be made and extracted in Scotland, and warehoused there without payment of duty, and which shall have been or shall be taken out of warehouse there for the purpose of being removed or imported into England for consumption, an additional duty of sixpence, and so in proportion, &c. (*as above.*) - - | 0 | 0 | 6 |
| 3 *&* 4 *V. c.* 17, *s.* 3. Upon every gallon of spirits of the strength of hydrometer proof which having been distilled in Scotland, shall be in warehouse, and be taken out of warehouse for consumption in Scotland or removed to England, an additional duty of - | 0 | 0 | 4 |

| | £ | s. | d. |
|---|---|---|---|
| IRELAND.—4 *&* 5 *W.* 4, *c.* 75. For and upon every gallon of spirits of the strength of hydrometer proof which shall be made or distilled in Ireland, or which shall be warehoused in Ireland and taken out for consumption - - - - - | 0 | 2 | 4 |
| And so in proportion for any greater or less degree of strength, or any greater or less quantity. | | | |
| For and upon every gallon of spirits of such strength as aforesaid, which shall be made or distilled in Ireland, and which shall be, or shall have been warehoused there free of duty; and which shall be taken out of warehouse for removal into Scotland for consumption | 0 | 3 | 4 |
| And so in proportion, &c. (*as above*). | | | |
| For and upon every gallon of the like spirits, which shall be taken out of warehouse for removal to England for consumption - - - - - | 0 | 7 | 6 |
| And so in proportion, &c. (*as above*) | | | |
| 3 *&* 4 *V. c.* 17, *s.* 3. Upon every gallon of spirits of the strength of hydrometer proof which shall be distilled in Ireland, or which having been distilled in Ireland, shall be in warehouse, and be taken out of warehouse for consumption in Scotland or Ireland, or for removal to England an additional duty of - - - | 0 | 0 | 4 |
| [And see allowances.] | | | |
| MIXTURES, &c.—6 *&* 7 *W.* 4, *c.* 72, *s.* 1, *and Sch.*—Ether; for every gallon thereof removed from Scotland to England - - - - - - - | 0 | 10 | 5 |
| From Ireland to England - - - - | 0 | 12 | 11 |
| From Ireland to Scotland - - - - | 0 | 2 | 6 |
| Sweet spirits of Nitre; camphorated spirits; lavender water, and other perfumes being spirits scented with essential oils, flowers or other ingredients; compound spirits of lavender; spirits of rosemary; spirits of ammonia; salvolatile; friar's balsam; compound tincture of Benzoin; tincture of Assafœtida; tincture of Castor; tincture of Kino; tincture of Guiacum; tincture of Myrrh; tincture of Ginger; and spirit varnishes; for every gallon thereof removed from Scotland to England - - - - - | 0 | 6 | 3 |

| | £ | s. | d. |
|---|---|---|---|
| From Ireland to England | 0 | 7 | 9 |
| From Ireland to Scotland | 0 | 1 | 6 |
| Other tinctures and medicated spirits; for every gallon thereof removed from Scotland to England | 0 | 4 | 2 |
| From Ireland to England | 0 | 5 | 2 |
| From Ireland to Scotland | 0 | 1 | 0 |
| Sweets, or made wines; for every gallon thereof removed from Scotland to England | 0 | 0 | 5 |
| From Ireland to England | 0 | 0 | 6 |
| From Ireland to Scotland | 0 | 0 | 2 |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every distiller or maker of low wines or spirits, within Great Britain or Ireland, the annual sum of | 10 | 0 | 0 |
| Every rectifier or compounder of spirits | 10 | 0 | 0 |
| Every dealer in spirits, not being a retailer thereof | 10 | 0 | 0 |
| Every maker of stills in Scotland or Ireland | 0 | 10 | 0 |
| Every person in Scotland or Ireland, not being a distiller, rectifier, or compounder of spirits, who shall keep or use any still for the carrying on the trade of a chemist, or any other trade or business requiring the use of any still or stills | 0 | 10 | 0 |
| Every retailer of spirits (except retailers of spirits in Ireland after mentioned) if the dwelling-house in which such retailer shall reside or retail such spirits at the time of taking out such licence, shall not, together with the offices, courts, yards, and gardens therewith occupied, be rated under the authority of any act or acts of parliament for granting duties on inhabited houses, at a rent of £10 per annum or upwards, or shall not be rented or valued at such rent or annual value, or upwards | 2 | 2 | 0 |
| If the same shall be rated, rented, or valued as aforesaid at £10 per annum or upwards, and under £20 | 4 | 4 | 0 |
| If at £20 and under £25 | 6 | 6 | 0 |
| If at £25 and under £30 | 7 | 7 | 0 |
| If at £30 and under £40 | 8 | 8 | 0 |
| If at £40 and under £50 | 9 | 9 | 0 |
| If at £50 per annum or upwards | 10 | 10 | 0 |

| | £ | s. | d. |
|---|---|---|---|
| Every retailer of spirits in Ireland, being duly licensed to trade in, vend and sell coffee, tea, cocoa-nuts, chocolate, or pepper, and not selling spirits in any greater quantity at one time than two quarts, or any spirits to be consumed in the house or premises of such retailer, if the dwelling-house in which such retailer shall reside or retail such spirits as aforesaid at the time of taking out such licence, shall not, together with the offices, courts, yards, and gardens therewith occupied, be rated under the authority of any act or Acts of Parliament for granting duties on inhabited houses, at a rent of £25 per annum or upwards, or shall not be rented or valued at such rent or annual value, or upwards - - - - - - | 9 | 9 | 0 |
| If the same shall be rated, rented, or valued as aforesaid, at £25 and under £30 - - - | 10 | 10 | 0 |
| If at £30 and under £40 - - - - | 11 | 11 | 0 |
| If at £40 and under £50 - - - - | 12 | 12 | 0 |
| If at £50 and upwards - - - - | 13 | 13 | 0 |
| ADDITIONAL.—3 & *V. c.* 17, *s.* 1.—Upon the produce and amount of all the aforesaid several duties of excise, except spirits made and distilled in the United Kingdom, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Allowances and Drawbacks.*

| | | | |
|---|---|---|---|
| 2 *W.* 4, *c.* 29.—For and upon every gallon of spirits, and so in proportion for any greater or less quantity of spirits of the strength of hydrometer proof, and so in proportion for any greater or less strength, distilled in Scotland or Ireland from malted corn only, not being mixed with any unmalted corn or grain whatever, after the rate of two gallons of such spirits for every bushel of barley malt, or one bushel and one-fourth of a bushel, and one-third part of a gallon of malt made from *bear* or *bigg* only, in respect of which spirits any distiller in Scotland or Ireland shall be charged with duty, during the time that such distiller shall use malt only, an allowance of - - - - - | 0 | 0 | 8 |
| 4 *G.* 4, *c.* 94. 6 *G. c.* 58, and Treasury warrant, dated May 11, 1826. If the malt used by any distiller of | | | |

| | £ | s. | d. |
|---|---|---|---|
| spirits from malt only be less than after the rate of one bushel for every two gallons of proof spirits charged on the distiller, the above allowance is subject to a deduction of 2s. 7d. for every bushel of malt so deficient. | | | |
| MIXTURES, &c.—6 & 7 *W.* 4, *c.* 72, *s.* 1, & Sch.—Ether; for every gallon thereof removed from England to Scotland | 0 | 10 | 5 |
| From England to Ireland | 0 | 12 | 11 |
| From Scotland to Ireland | 0 | 2 | 6 |
| Sweet spirits of Nitre; camphorated spirits; lavender water, and other perfumes, being spirits scented with essential oils, flowers and other ingredients; compound spirits of lavender; spirits of rosemary; spirits of ammonia; salvolatile; friars balsam; compound tincture of Benzoin; tincture of Assafœtida; tincture of Castor; tincture of Kino; tincture of Guiacum; tincture of Myrrh; tincture of Ginger; and spirit varnishes; for every gallon thereof removed from England to Scotland | 0 | 6 | 3 |
| From England to Ireland | 0 | 7 | 9 |
| From Scotland to Ireland | 0 | 1 | 6 |
| Other tinctures and medicated spirits; for every gallon thereof removed from England to Scotland | 0 | 4 | 2 |
| From England to Ireland | 0 | 5 | 2 |
| From Scotland to Ireland | 0 | 1 | 0 |
| Sweets or made wines; for every gallon thereof removed from England to Scotland | 0 | 0 | 5 |
| From England to Ireland | 0 | 0 | 6 |
| From Scotland to Ireland | 0 | 0 | 2 |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 4.—Upon any allowance or drawback now due on all goods and commodities entitled to allowance, on removal thereof to Ireland, which shall be so removed, an additional allowance or drawback of | £5 *per cent.* | | |

### 4. *Process of Distillation, &c.*

The process of the distiller comprehends the brewing and fermentation of wort, and the separation of the spirits therefrom by distillation.

Malt or grain wort is made by mixing with hot water in the mash tun, malt or grain which has been ground or bruised. After the ingredients have been properly mixed or mashed, the infusion is left at rest for some time. The liquor is then drawn off by means of a cock or plug at the bottom of the mash-tun into the wort-underback. More water is added, and the infusion repeated in a similar manner till the malt or grain is exhausted. Sugar wort is made by mixing sugar and water in the fermenting back, or mash-tun. The wort thus obtained from malt or grain is conveyed to the coolers, and when brought to a due temperature, is conveyed into the fermenting backs. Yeast, or bub, is afterwards added to induce fermentation, which is carried as far as practicable. By the process of fermentation, the saccharine matter contained in the wort is gradually converted into spirits; and the wort is attenuated, or rendered more light, in proportion to the decomposition of the saccharine matter and its conversion into alcohol. The wort when fermented is called "wash". The wash thus prepared is conveyed to the wash-charger, and thence into the wash-still where it is made to boil, and the spirituous parts arising in vapour, are condensed in the worm (which is surrounded with cold water,) and flow directly from the worm-end into the low-wines' receiver. In this state the produce is called "low-wines" or spirits of the first extraction. The low-wines are removed from the receiver into the low-wines' charger, and thence into the low-wines' still; and being there boiled, and the vapour condensed as above described, the spirits issue from the worm-end, and are conveyed to the spirit receiver. The impure parts called "feints," are conveyed into the feints' receiver; and are afterwards purified by repeated distillations, either alone or mixed with low-wines produced from a subsequent distillation of wash.

*Rectifiers* and *Compounders* receive their spirits in a plain state from the distiller, and by passing them through their stills which is called "rectification," they produce rectified spirits which, if of the strength of 43 per cent. over proof, or upwards, are called "spirits of wine;" and by adding flavouring articles to spirits of less strength which is called "compounding," they produce British brandy and British compounds.

*Dealers* in spirits are those who sell in quantities not less than two gallons. *Retailers* are those who sell spirits in a less quantity, and which may be consumed on their premises. There is also in Ireland another description of retailers who are licenced as *Grocers*, and who are not allowed to sell in quantities exceeding two quarts, nor any spirits to be consumed on their premises.

### 5. *Regulations for securing the duty.*

A distiller in *England*, not established in 1825, must occupy and pay rates for premises in or near a market town, of the annual value of £20 at least, 6 G. 4, c. 80, s. 9, 10, 11, and no still can be used of less capacity than 400 gallons, s. 10. And a distillery cannot be carried on upon the same premises with the business of a rectifier, brewer, sweets maker, vinegar maker, cider maker, or refiner of sugar, or communicating therewith, or within a quarter of a mile of a rectifying house, 6 G. 4, c. 80, s. 36; 4 G. 4, c. 94, s. 131, 132. In *Scotland* or *Ireland*, no still can be used of less content than 40 gallons, and no licence granted for a still of less content than 500 gallons without a magistrate's certificate, 4 G. 4, c. 94, s. 10; and the Board may refuse to licence small stills, or when there is a rectifier, brewer, &c. in the immediate neighbourhood, s. 13.

After having obtained a licence, and before making entry, every distiller is required to erect the following utensils in prescribed forms, viz. one wash-charger, one low-wines receiver, one low-wines and feints-charger, one feints-receiver, and one spirit-receiver. He may also erect, in addition, one low-wines receiver, one low-wines and feints-charger, and one feints-receiver; and in *England*, (in case the distiller shall be desirous of having the discharge cock of his low-wines still unsecured,) one spent-lees receiver; 6 G. 4, c. 80, s. 13, 15; 4 G. 4, c. 94, s. 18, 20. Chargers and receivers are required to have dipping-holes made, and dipping-rods inserted *id.* In the breast of stills, holes or openings are to be made for the officers to take samples, 6 G. 4, c. 80, s. 17; 4 G. 4, c. 94, s. 24. The end of every worm is to be enclosed in a safe, unless the Treasury shall dispense with the use thereof, 6 G. 4, c. 80, s. 18; 4 G. 4, c. 94, s. 26. Proper discharge cocks, pumps, locks and fastenings are also to be provided at the expense of the distiller, 6 G. 4, c. 80, s. 18, 19, 20, 21; 4 G. 4, c. 94, s. 28; and proper dipping places with metal plates made in the fixed vessels, 6 G. 4, c. 80, s. 24; 4 G. 4, c. 94, s. 31; and the position or size of any vessel, is not to be altered without notice, 6 G. 4, c. 80, s. 26; 4 G. 4, c. 94, s. 39. The officers may order the water to be drawn off from any worm-tub for examination, 6 G. 4, c. 80,

s. 28: 4 G. 4, c. 94, s. 106. And the true content, &c. of casks is to be marked thereon, 6 G. 4, c. 80, s. 29; 4 G. 4, c. 94, s. 32.

Every distiller is required to make entry of his premises and utensils, distinguishing them by particular letters and numbers; and is also to distinguish his pipes by particular colours, 6 G. 4, c. 80, s. 30, 37; 4 G. 4, c. 94, s. 34, 36. And the officers are thereupon, empowered to survey, 6 G. 4, c. 80, s. 39, 43; 4 G. 4, c. 94, s. 104.

A distiller is not allowed to brew or distil on a Sunday, nor to brew and distil at the same time, 6 G. 4, c. 80, s. 12, 50; 9 G. 4, c. 94, s. 41, 112.

Every distiller before he begins to prepare worts, or, having discontinued for a longer periodh tan a month, before he recommences is required to give *six days'* notice, setting forth the materials he intends to make use of, (which must be grain or malt, sugar, potatoes or mangel-wurzel, *unmixed*); and the particular gravity of the wort he intends to prepare; which gravity in *England* must not exceed 90 degrees, nor be less than 50; and in *Scotland* or *Ireland*, must not exceed 80 degrees, nor be less than 30; 6 G. 4, c. 80, s. 44, 52; 4 G. 4, c. 94, s. 44, 47; 2 & 3 W. 4, c. 74. And no wort is to be in any distillery in *England*, except in the mash-tun, wort-underback, coolers or coppers, which exceeds the gravity specified in such notice, 6 G. 4, c. 80, s. 52; and no wort is to be in any distillery in *Scotland* or *Ireland*, except in the mash-tun, or wort-underback which exceeds the notice gravity by three degrees, 4 G. 4, c. 94, s. 44. But the gravity may be changed at the end of a month on giving *six days'* notice, 6 G. 4, c. 80, s. 52; 4 G. 4, c. 94, s. 44.

Before a distiller commences brewing, he is required to give *six* hours' notice; and then or within *six* hours' after the brewing, to declare the true quantity and kind of materials used, or to be used, 6 G. 4, c. 80, s. 51, 52; 4 G. 4, c. 94, s. 42, 43. The worts of two or more brewings are not allowed to be mixed together, 6 G. 4, c. 80, s. 51; 4 G. 4, c. 94, s. 43. The worts are to be collected in the fermenting-back within eight hours in England, and six hours in Scotland or Ireland; immediately after which a declaration of the gravity and quantity is to be delivered, and nothing capable of exciting fermentation is to be added for two hour's afterwards, unless the officer shall sooner have taken account of the worts, 6 G. 4, c. 80, s. 54; 4 G. 4, c. 94, s. 48. In *Scotland* and

*Ireland*, the worts are allowed to be cooled in a worts' receiver under certain regulations, 4 G. 4, c. 94, s. 46. If *bub* be used by any distiller, six hours' notice in writing is required before making it, and the quantity is restricted to five gallons for every hundred gallons of wort. The gravity must not exceed the lawful gravity of the wort; and it must be conveyed into the fermenting-back within 24 hours after the time specified in the notice, 6 G. 4, c. 80, s. 57; 4 G. 4, c. 94, s. 50.

Before a distiller commences distilling, he is required to give a declaration, specifying that the whole of the worts and wash in his distillery are collected in the fermenting backs; and the officer is required at any time not less than twelve hours after receiving such declaration, to remove the fastenings of the stills, 6 G. 4, c. 80, s. 58, 59; 4 G. 4, c. 94, s. 51.

*Eight* hours' notice is required previously to the removal of wash from the fermenting-back to the wash-charger; and on the officer's attendance and removal of the fastenings, and securing the charging cock of the wash-still, the wash is to be conveyed into the wash-charger, 6 G. 4, c. 80, s. 59; 4 G. 4, c. 94, s. 52. In *England* the discharge cock is allowed to be opened only once in *six* hours on a reasonable notice, except where a spent lees' receiver is fixed, when no discharge cock is required, 6 G. 4, c. 80, s. 19; but in *Scotland* or *Ireland*, it is left unsecured, except by a valve.

The low-wines produced from the distillation of the wash contained in each fermenting-back, are required to be collected in the low-wines' receivers, from which they are not allowed to be removed without *four* hours' notice, 6 G. 4, c. 80, s. 59, 64; 4 G. 4, c. 94, s. 54.

The spirits and feints produced from the distillation of low-wines, are collected in receivers, from which after the officer has taken account of them, they can be removed on *four* hours' notice, 6 G. 4, c. 80, s. 64, 65; 4 G. 4, c. 94, s. 54, 55.

There are three modes of charge for the duty, by 6 G. 4, c. 80, s. 66—74; 4 G. 4, c. 94, s. 56—59, viz:—

1st.—One gallon of proof spirits per 100 gallons of wash for every *five* degrees of the gravity attenuated, that is, the difference between the gravity of the wort previous to, and after fermentation.

2nd.—From the quantity of proof spirits contained in the low-wines; *two* per cent. being allowed in *England*, and *five* in *Scotland* and *Ireland*, for waste arising from the distillation of the low-wines into spirits and feints.

3rd.—From the quantity of proof spirit contained in the spirits and feints produced from the distillation of the low-wines.

The distiller is charged with duty on the greatest quantity arising from any one of those modes of charge.

Besides those three modes of charge, an account is kept of the quantity and gravity of the wort prepared by every distiller during the continuance of his licence, and of the quantity of spirits upon which he has been charged with duty; and if, at the expiration of his licence, he shall not have been charged with duty on a quantity of spirits, in the proportion of one gallon of proof spirit per cent. of wash, for every five degrees of the original gravity of such wort if prepared from grain, potatoes, or mangel-wurzel, or for every four degrees if prepared from sugar, he is chargeable with the quantity deficient, exclusive of undue excesses,—namely, excesses arising on any distillation of wash above the produce of one gallon and a fifth of spirits per cent. of wash for every five degrees of gravity, 6 G. 4, c. 80, s. 66, 71; 4 G. 4, c. 94, s. 60.

The officer is to make a return of the duty, and such duty is to be paid as the Commissioners shall direct. In England the returns are made at the end of each week for each distilling period finished; and the duty is paid within *fourteen* days afterwards. In Scotland and Ireland, the returns are made within *six* days after each distilling period, and the duty is paid within *six* days afterwards, 6 G. 4, c. 80, s. 72, 73; 4 G. 4, c. 94, s. 62, In England also, the distiller is required to make entry of the wash distilled, and spirits made and the malt used in each period, 6 G. 4, c. 90, s. 73.

Any officer of the rank of Supervisor, may distil into low-wines all the wash contained in any fermenting-back; or take a sample of wash, not exceeding *twenty* gallons, and distil it into low-wines in a still provided by the Commissioners of Excise; and if the proof spirits contained in any such low-wines, shall exceed the proportion of one gallon and a quarter per cent. of wash for every five degrees of gravity attenuated, the distiller incurs a penalty, 6 G. 4, c. 80, s. 60, 61, 62; 4 G. 4, c. 94, s. 123, 124, and 125.

No spirits are to be sent out of a distiller's stock, expect such as shall be distilled in his distillery, 6 G. 4, c. 80, s. 75; nor of any other strength than 25 or 11 per cent. over proof, or 10 per cent. below proof; nor in any less quantity than 80 gallons in England, or 9 gallons in Scotland or Ireland; nor without being accompanied with a permit, 6 G. 4, c. 80, s. 81; 4 G. 4, c. 94, s. 120.

And an account of such stock is to be kept by the officer, and any undue increase or decrease, incurs a penalty, 6 G. 4, c. 80, s. 79; 4 G. 4, c. 94, s. 65.

In England, spirits may be *warehoused* free of duty for exportation to foreign parts, or removal to Scotland or Ireland, under such regulations as the Board shall approve, proper notice being given to the officer, who is to attend the removal, and keep an account thereof in the warehouse, 6 G. 4, c. 80, s. 82, 90.

In *Scotland* and *Ireland*, distillers are allowed to warehouse spirits without payment of duty, for home consumption as well as for exportation to foreign parts, and for removal to any part of the United Kingdom. But in either case, the officer in charge of the distillery cannot give credit in his charge on the distiller, for spirits warehoused, until the receipt of the warehouse-keeper for the same is delivered to him, 4 G. 4, c. 94, s. 66—71; 7 G. 4, c. 49, s. 7; and 6 & 7 W. 4, c. 72, s. 10. No spirits can be removed from one part of the United Kingdom to another, except directly from the warehouse; and on their arrival, they are subject to the same regulations as spirits made in the part of the country to which they are removed. The duties on deficiencies of spirits warehoused, are chargeable at the same rate as spirits in that part of the country where they are warehoused, 6 G. 4, c. 80, s. 88, 89, 91, 92; and 4 & 5 W. 4, c. 75, s. 4 & 5. On delivery of spirits from the warehouse in *England* for removal to *Scotland* or *Ireland*, the English duty thereon is required to be paid; and on the production of a certificate from the proper officer, of the landing of the spirits in the country to which so removed, the difference between the amount of the English duty and the amount of the Scotch or Irish duty (as the case may be) is, under the directions of the Commissioners of Excise, to be repaid on the quantity landed, 6 G. 4, c. 80, s. 93, 97.

On the delivery of spirits from the warehouse in *Scotland* or *Ireland* for removal to England, the full English duty is to be paid, or so much thereof as shall be equal to the amount of duty payable on such spirits when delivered for home consumption in *Scotland* or *Ireland*, and a bond given for payment of the residue within *two* months from the date of the bond, or *twenty-one* days after the arrival of the spirits in England, 6 G. 4, c. 80, s. 93, 94.

Spirits cannot be warehoused of any other strength than *twenty-five*, or *eleven* per cent. over proof, nor in casks of less content than *twenty* gallons, nor can they be removed by sea in vessels of less burthen than fifty tons, 6 G. 4, c. 80, s. 82, 96; 4 G. 4, c. 94, s. 66; and 6 & 7 W. 4, c. 72, s. 10.

*Rectifiers* are to make entry of their premises and utensils, 6 G. 4, c. 80, s. 20; which are to be open to the inspection of the officers, s. 107; and no person is deemed to be a rectifier who shall not have at least one still of 120 gallons content, exclusive of the head, s. 103. The business of a rectifier cannot be carried on within a quarter of a mile of a distillery, nor upon the same premises or communicating with those of a brewer, sweets, vinegar, cider or perry maker, or sugar-refiner, or dealer in or retailer of spirits, s. 35, 36. A rectifier is not to have in his custody any wash, or other fermented liquor capable of being distilled into spirits, s. 102; and not to use any still on a Sunday, s. 12; and he is required to provide proper fastenings to his stills, 6 G. 4, c. 80, s. 22, 104; and the necessary means for enabling the officer to take samples; and to assist him when necessary, with ladders and lights, s. 42.

A rectifier must charge his still with liquor, before commencing to work, in the proportion of not less than seven-tenth parts of the content of the still including the head, and work off the same within *sixteen* hours, 6 G. 4, c. 80, s. 105. *Twelve* hours notice of working any still is to be given to the officer who is to attend and open the furnace door, and fasten down the head of the still if moveable, or if fixed, to secure the charging pipe leading thereto, 3 G. 4, c. 52, s. 73, & 74.

On receiving spirits into stock, notice is to be given and the permit, delivered to the officer, and bulk is not to be broken until the officer shall have taken account thereof or within *two* hours after giving the notice, s. 111.

Rectifiers are not to receive or send out spirits without permit nor to send out a less quantity at one time and to one person than *two* gallons in bulk; and, (in order to preserve a distinction between compounded spirits, Foreign, and Colonial spirits, and plain British spirits,) compounded spirits, not being spirits of wine, are not allowed to be sent into consumption at a strength exceeding 17 per cent. under proof; and other spirits are not allowed to be sold or sent out to any retailer of spirits 6 G. 4, c. 80, s. 113; and 6 & 7 W. 4, c. 72, s. 13. As the hydrometer will not indicate the strength of sweetened spirits, the rectifier is required to mark the true quantity and strength on the casks containing the same, 6 G. 4, c. 80, s. 112. If, on balancing the stock account, any undue increase appears, it is forfeited, and a penalty is incurred; and if a decrease beyond the quantities sent out by permit and exceeding *five per cent.* a penalty is also incurred; which, however, in practice is not sued for, unless such decrease shall be greater than four gallons in any one kind of spirits over the quantity permitted since the stock was last taken; s. 109, 117.

*Dealers and Retailers* are required to make entry of their premises, 6 G. 4, c. 80, s. 30. Retailers must be authorized by magistrates' certificate to keep a public-house, before they can obtain an excise licence, which authorizes them to sell foreign and colonial, as well as home-made spirits, 6 G. 4, c. 81, s. 2; (and see as to England, 9 G. 4, c. 61; Scotland, 9 G. 4, c. 58.) Dealers receiving any quantity of spirits, and retailers receiving spirits in a less quantity than 80 gallons, are required to give notice to the officer, and deliver the permit; and not to break bulk until the officer shall have taken an account, or within *two* hours after notice given, 6 G. 4, c. 80, s. 111. No spirits are allowed to be brought into an entered stock without a permit; and all spirits exceeding the quantity of one gallon found removing without permit, are subject to forfeiture, s. 115, 116, 117. No retailer is allowed to take out a permit for the removal of spirits, except to private persons, unless he takes out a dealer's licence in addition to his retail licence, s. 129. Spirits of wine in the stocks of dealers and retailers, are required to be kept in separate rooms from other spirits; and Foreign and Colonial, and British spirits in the stock of dealers are required to be kept in separate rooms, s. 114, 126. Retailers are not allowed to be concerned in the distillation, rectification or compounding of spirits, s. 128. Foreign or Colonial and British spirits are not to be mixed in the same vessel, s. 126. Foreign or Colonial spirits, and plain British spirits are not to be kept in any retailer's stock of a strength less than 17 per cent. under proof, nor any British compounds (except shrub) above that strength, 6 G. 4, c. 80, s. 124. But dealers not being retailers, may receive, keep, and send out to any other dealer in spirits, or to any person not being a retailer, any Foreign or Colonial spirits of any strength, subject to the usual regulations, 6 & 7 W. 4, c. 72, s. 14.

Credit is given in stock for the quantity of liquor necessary to reduce Foreign or Colonial spirits to any strength, not less than 17 per cent. under proof, provided it be done on notice, and in the presence of the officer, 6 G. 4, c. 80, s. 126.

If any decrease be found in a dealer's stock greater than 5 *per cent.*, a penalty is incurred. But see *Board's Order* of March 25, 1826.

In surveying distillers, the duty of the officer is to examine the premises and utensils; and also to gauge and secure such of the utensils as require it; and to attend the various notices, and see that the processes are carried on according to such notices, and the requirements of the law; and where any utensil is under the revenue fastenings, the officer is strictly prohibited from allowing them to be open when he is not present, or the keys to be out of his possession at any time. During the brewing period, the officer's attention is particularly directed to the quantity and gravity of the wash; in order to obtain which, and to prevent the introduction of strong worts or other frauds, he is required to take an account of the quantity and gravity of the wort or wash in each fermenting-back once, at least, during his course of eight hours. He is also to take an account of the bub or fermenting composition, and when practicable, attend at the time it is added to the wort. During the process of fermentation the attention of the officer is chiefly directed to obtaining correct accounts of the quantities and gravities of the wash; and during that of the distillation, of the low-wines produced therefrom, and of the spirits and feints produced from the low-wines; and for the prevention of frauds by the private removal of spirits during the process.

The stocks of *Rectifiers* are to be taken account of, at least, once in forty-two days; when the quantity on hand is to be very carefully ascertained, and the actual strength whenever practicable, and balanced with the quantity found on taking the preceding account.

The stocks of *Dealers* are to be taken at least, once in twenty-eight days, and again once in each quarter within seven days after taking such account.

For the detection of *private stills*, the officers are empowered to obtain and execute search warrants; and in the detection, if any person is found at work, they have a power of immediate arrest and conviction, 6 G. 4, c. 80, s. 39, &c. In *Scotland* and *Ireland*, the officers are empowered to search without warrant; and there are other special provisions for putting down private distillation, see 1 & 2 W. 4, c. 55.

As to the allowance in respect of the malt duty on spirits made in Scotland and Ireland from malt only, see 7 & 8 G. 4, c. 52; 11 G. 4, c. 17, and see *Malt.*

## Sugar.

### 1. *Duties.*

| | |
|---|---|
| 3 & 4 *V. c.* 57, *s.* 1.—On every hundred weight and so in proportion, for any greater or less quantity of all sugar manufactured in the United Kingdom from whatever materials made - - - | The same amount of duty as is by law payable on sugar made from Beet Root. |

*And see p.* 296.

## Sweets.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every retailer of sweets or made wines, or of mead or metheglin - | 1 | 1 | 0 |

ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1.—On the produce and amount of the above duty, an additional duty of £5 *per cent.*

### 2. *Excise Regulations.*

No sweets can be retailed to be consumed on the premises without a magistrate's authority, 6 G. 4, c. 81, s. 14; 4 & 5 W. 4, c. 85, s. 16; and see as to England, 9 G. 4, c. 61; Scotland, 9 G. 4, c. 58.

## Tea.—See *Coffee, &c.*

## Tobacco and Snuff.

### 1. *Duties.*[†]

| | £ | s. | d. |
|---|---|---|---|
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every manufacturer of tobacco or snuff, if the tobacco and snuff-work weighed by such person for manufacture within the year ending the fifth day of July previous to taking out such licence, shall not have exceeded 20,000 lbs. weight - - - - - - - | 5 | 0 | 0 |
| If the same shall exceed 20,000 lbs., and shall not exceed 40,000 lbs. weight - - - - | 10 | 0 | 0 |
| If the same shall exceed 40,000 lbs., and shall not exceed 60,000 lbs. weight - - - - | 15 | 0 | 0 |

---

[*] Formerly there was an excise duty on sweets, but this duty (except the licence duty on retailers) was repealed by 4 & 5 W. 4, c. 77. There are countervailing duties and drawbacks on the removal of sweets from one part of the United Kingdom to another, for which, see p. 337, 340.

[†] Formerly there was an excise duty on the importation of tobacco, but it was transferred to the Customs in 1825.

| | £ | s. | d. |
|---|---|---|---|
| If the same shall exceed 60,000 lbs., and shall not exceed 80,000 lbs. weight - - - - | 20 | 0 | 0 |
| If the same shall exceed 80,000 lbs., and shall not exceed 100,000 lbs. weight - - - - | 25 | 0 | 0 |
| If the same shall exceed 100,000 lbs. weight - - | 30 | 0 | 0 |
| Every person who shall first become a manufacturer of tobacco or snuff, on taking out such licence as aforesaid for that purpose, shall pay the sum of five pounds, and shall, within ten days after the fifth day of July next after taking out such licence, pay such further sum as with the said sum of five pounds, shall amount to the duty herein-before mentioned according to the quantity of tobacco and snuff-work weighed for manufacture within the preceding year or period for which such licence was granted - - - - | 5 | 0 | 0 |
| Every dealer in or seller of tobacco or snuff - - | 0 | 5 | 0 |
| ADDITIONAL.—3 & 4 *V. c.* 17, *s.* 1.—From May 15, 1840, upon the produce and amount of the foregoing duties, an additional duty of - - - - | £5 *per cent.* | | |

### 2. *Excise Regulations.*

Manufacturers, dealers, and retailers of tobacco and snuff, are to enter their premises, 3 & 4 V. c. 18, s. 2; and officers are empowered to survey, s. 3.

Leaf or unmanufactured tobacco is not to be received into a manufacturer's stock, but from the warehouse, and accompanied by a permit, s. 4; which is to be delivered up on the next visit of the officer, s. 5. No leaf or unmanufactured tobacco to be removed without a permit, s. 6. Tobacco stalks, and returns not to be removed in any quantity less than 50 lbs. weight, nor without a certificate, s. 7.

A book is to be delivered to manufacturers, who are to enter therein all tobacco received, with the name of the person from whom received; which book is to be open to inspection, s. 8; and the licence duty on the manufacturer, to be rated on the quantities received in the year previous, s. 9; the book being produced on applying for the licence and declaration made of the truth of the entries therein, s. 10.

No person to cut colour or manufacture leaves of trees, &c., to imitate tobacco, s. 11; nor to hawk about tobacco or snuff for sale, s. 12. No drawback is allowed on cut, roll, or carrot tobacco, containing stalks, s. 13; nor on tobacco not properly manufactured, or containing unlawful ingredients, s. 14; and a penalty is incurred on fraudulently attempting to obtain drawback, s. 15.

## Vinegar.

### 1. *Duties.*[*]

| | £ | s. | d. |
|---|---|---|---|
| 6 *G.* 4, *c.* 37.—For and upon every one hundred gallons, imperial standard gallon measure, of vinegar or acetous acid, or liquors prepared or preparing for vinegar or acetous acid, brewed or made in any part of the United Kingdom of Great Britain and Ireland for sale, to be paid by the maker thereof, and so in proportion for any greater or less quantity (being per gallon 2d.) - - - - - - | 0 | 16 | 8 |
| LICENCES.—6 *G.* 4, *c.* 81, *s.* 2.—Every maker of vinegar or acetous acid for sale, the annual sum of - | 5 | 0 | 0 |
| ADDITIONAL.—3 & 4 *V.* *c.* 17, *s.* 1.—From May 15, 1840, upon the produce and amount of the foregoing duties, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Process of Manufacture.*

Vinegar or acetous acid, for commercial purposes, is frequently made in Great Britain from malt, in the manner in which ale is brewed, except boiling with hops; at other times it is made with sugar, molasses or other materials, separately, or mixed with water; and, to sour it, sometimes the casks are laid in the sun with the bungs open during summer, and in winter in stoves used for the same purpose. In most cases, rapes are used (*i. e.*) vats partly filled with raisins which have been previously used in the manufacture of home-made wines or sweets, to fine the vinegar when perfectly made. *Distillation*, which is occasionally had recourse to, does not strengthen vinegar, but frees it from mucilage and other impurities.

A crude vinegar has long been obtained from wood, for the use of calico printers, called pyroligneous acid, which when first condensed, consists of a mixture of tar and acid. The tar is partly deposited by its own weight, but to precipitate it effectually, it is either redistilled or mixed with lime or other ingredients. It is then saturated with lime or soda.

---

[*] Vinegar-beer was one of the articles on which a duty was imposed by the original act of 12 Car. 2, c. 24. The net revenue arising from this duty in 1839, was as follows:—England, £24,347; Scotland, £120; Ireland, [illegible]

### 3. *Regulations for securing the duty.*

Every vinegar maker is required to make entry of his premises, specifying the materials he intends to use, 26 G. 3, c. 73, s. 56; 35 G. 3, c. 89; and such premises must not be within 300 yards of a pyroligneous acid, white lead, sugar of lead, verdigris, iron-liquor, or acetate of lime, soda, or acetate of alumine maker 58 G. 3, c. 65, s. 15.

All liquor made into or capable of being used as vinegar or acetous acid for sale, is to be deemed vinegar, 10 & 11 W. 4, c. 21, s. 11; 58 G. 3, c. 65, s. 6, 24; 8 A. c. 7, s. 4; except vinegar made and used in making white lead, s. 5; and pyroligneous acid in its crude state, or white lead, sugar of lead, verdigris, iron liquor, acetate of lime, soda or alumine, or vinegar made and used in making the aforesaid compounds, 58 G. 3, c. 65, s. 6.

The officers are allowed to enter survey and gauge, leaving a copy of their charges with the maker, 7 & 8 W. 4, c. 30, s. 17, 25, 26; 58 G. 3, c. 65, s. 10; and the officers may try the strength of vinegar, with such acetometer as the Board may direct, s. 8, and may take samples on certain conditions, s. 9.

Vinegar makers are not to receive materials, nor send out vinegar without notice, or at improper hours, 10 & 11 W. 3, c. 21, s. 12; 7 & 8 W. 3, c. 30, s. 18; 10 & 11 W. 3, c. 21, s. 13; 58 G. 3, c. 65, s. 11; and no person, not being an entered maker, to send out vinegar or materials, except to an entered vinegar-maker under permit, s. 12; and vinegar removed from the manufacture to be accompanied with permit, s. 21. Penalty for concealing vinegar or materials, s. 25; or for using a still for any unlawful purpose, s. 13, or for an unlawful excess in stock, s. 23. Vinegar may be diluted after it has been charged, on notice, and in the presence of the officer, s. 14.

*Pyroligneous acid* for sale, is to be rectified only from pyrolignite or acetate of lime or soda, 58 G. 3, c. 65, s. 15; and vinegar makers being rectifiers of acetous acid, are required to provide proper warehouses for depositing the concrete acetates under the care of the officers, s. 16; and the materials are to be weighed and delivered out on notice, s. 17, 18; and kept in a tared vessel until taken account of, s. 19; and any unlawful deficiency is to be charged with duty, s. 20.

It is the duty of the officers to keep the traders to a compliance with the legal regulations respecting entries, notices, &c. They are to gauge the utensils used by vinegar makers; and, from time to time, take an account of the vinegar, materials and preparations in stock and process of manufacture. A manufacturer's stock is to be taken once a day, (Sundays excepted) unless there be a special order to the contrary; and the officer is to attend if possible when notice is given for diluting, and for unlocking the stills, &c. When the stills are not at work, they are to be carefully secured.

In surveying pyroligneous acid makers, the great object is to ascertain that no vinegar for sale is made or introduced.

## Wine.

### 1. *Duties.**

| | £ | s. | d. |
|---|---|---|---|
| 6 *G.* 4, *c.* 81, *s.* 2.—Every dealer in foreign wine, who shall not have an excise licence for retailing spirits, and a licence for retailing beer, the annual sum of - | 10 | 0 | 0 |
| Every retailer of foreign wine, who shall have taken out a licence for retailing beer, to be drank or consumed on his, her, on their premises, but shall not have taken out an excise licence for retailing spirits to be so drunk or consumed - - - - | 4 | 4 | 0 |
| Every retailer of foreign wine, who shall have taken out excise licences for retailing beer and spirits, respectively to be so drank or consumed - - - | 2 | 2 | 0 |
| ADDITIONAL.—3 & 4 *V.* *c.* 17, *s.* 1.—From May 15, 1840, upon the produce and amount of the foregoing duties, an additional duty of - - - | £5 *per cent.* | | |

### 2. *Excise Regulations.*

Every dealer in and seller of foreign wine, is to make entry of his premises, which are to be open to the inspection of the officers, 26 G. 3, c. 59, s. 12, 13. See also 9 G. 4, c. 44, s. 1, 4, and Board's orders. No licence for selling wine to be consumed on the premises, can be granted without a magistrate's authority, 6 G. 4, c. 81; 4 & 5 W. 4, c. 85, s. 16; and see as to England, 9 G. 4 c. 61; and as to Scotland, 9 G. 4, c. 58.

---

* Formerly there was an excise duty on the importation of wine, but it has been transfered to the customs.

# INDEX.

ACCOUNTS, *page* 282.
ACTIONS against Officers, 277.
ADDITION,
    Simple, 3.
    Compound, 33.
    of vulgar fractions, 14.
    of decimals, 15.
ALLIGATION, 41.
ANGLES, 67.
    Axioms and Theorems, 67.
    Problems, 69.
ANGULAR MEASURE, Table of, 67.
APPOINTMENT of Officers, 248.
AREAS, Table of,
    for circles, 155—160.
    for semi-squares, 148—152.
    for circular segments, 153, 154.
    for regular polygons, 152.
    for regular bodies, 147.
    for the head diameters of casks, 244.
    for the bung diameters of casks, 245.
    for the differences between the head and bung diameters, 244.
ARITHMETIC, 1.
    of simple numbers, 1.
    of quantities, 23.
ARITHMETICAL TABLES, 2, 3, 5, 13, 17, 19, 48—60.
ASSISTANTS, 250.
AUCTIONS,
    duties, 290.
    licence for selling by, 291.
    regulations for securing the duty, 291.
    rules for calculating the duty on, 39.
AVERAGING AND COMPOUNDING SPIRITS, 41, 242.

AVOIRDUPOIS WEIGHT, 24
- Tables of, 50, 51.

BALANCE, 24.
- to detect false, 24.

BEER, brewer's licences, 293.
- dealer's licences, 294.
- retailers licences, 295.
- drawback on, 312.
- excise regulations, 295, 319.

BEET-ROOT SUGAR, 296.
- duties, 296, 350.
- regulations for charging the duty, 296.

BOARD OF EXCISE, constitution of, 247.

BODIES REGULAR, 147.
- tables of areas, 147.

BOOK-KEEPING, 276.

BREWERS,
- licence for, 293.
- guile tun to gauge, 195.
- mash tun to gauge, 196.

BRIBERY, 251.

BRICKS, 297.
- duties, 297.
- drawbacks, 297.
- process of manufacture, 298.
- regulations for charging the duty, 298.

BUNG ROD, 229.

BUSHELS,
- dimensions of, 29, 54.
- table for converting inches into, 55.

CALLIPERS,
- gauging by, 224.

CASKS,
- definition of, 218.
- gauging, by the diagonal rod, 218, 219.
- varieties of, 220.
- usual forms and dimensions of, 246.
- table of regular spheroidal, 220.
- to find the content by a middle diameter, 222.
- to find a middle diameter, 223.
- to take the dimensions, 224.
- to find the head diameter, 225.
- to find the bung diameter, 226.
- to find the length, 228.
- to find the wet inches, 229.
- to cast the content with the head rod, 230.

CASKS, *continued.*
  to find the content with the line X, 231.
  to find the content with the sliding rule, 232, 233.
  to find the content by the pen, 234—236.
  to find the content by the table of head and bung diameters and differences, 235, 244, 245.
  to cast the ullage of a lying cask, 181, 237, 238.
  to cast the ullage of a standing cask, 181, 238, 239.
  to inch a cask, 239.
CHIEF OFFICE OF EXCISE, limits of, 274.
CIDER,
  licences for, 295.
CIRCLES,
  theorems, 85.
  problems, 86.
  to find the area, 89, 90, 106.
  table for finding the areas of, 155.
  to find a divisor for, 91.
  to find a factor for, 91.
  divisors factors, and gauge points for, 57, 173, 303.
CIRCULAR AREAS,
  table of, for gallons, 155—160.
  application of, 91, 99, 120, 127, 185.
CIRCULAR RINGS, 94.
CIRCULAR SEGMENTS, 92.
  table of areas of, 153, 154.
CIRCULAR SPINDLE, 144.
COFFEE, COCOA-NUTS, AND CHOCOLATE,
  licence duties, 299.
  excise regulations, 299.
COINS,
  table of the value and weight of, 48.
COLLECTORS, 247, 253.
COLLECTIONS, schemes of, 256.
COMMISSION,
  rule for calculating, 47.
COMMISSIONERS,
  board of, 247.
COMPOUND,
  addition, 33.
  subtraction, 34.
  multiplication, 35.
  division, 36.
  proportion, 37.
CONIC SECTIONS, 95.
CONOIDS, 140.

CONICAL UNGULAS, 125.
CONES,
  theorems, 123.
  to find the content, 126.
  frustum of, 124, 129, 220, 230—235.
COOLER, to gauge, 197.
COPPER,
  with a rising crown, to gauge, 204.
  with a falling crown, to gauge, 206.
COUCH BUSHELS,
  to reduce cistern bushels to, 184.
  table for calculating, 240.
COUCH FRAME,
  to gauge, 178, 183.
COUNTRY ESTABLISHMENT, 255.
CUBE, 20, 115.
  theorems, 114.
  to find the content, 117, 147.
CUBE ROOT, to extract, 19, 20, 172.
CUBIC MEASURE, 27.
  table of, 57.
CURVED LINES, 65.
CYLINDER, 116.
  theorems, 114.
  to find the content, 117, 120, 168, 185.
  frustum of 114.
CYLINDRICAL VESSEL, to gauge, 185, 120.
DECIMALS,
  definition and table, 13.
  to reduce to the proper denomination, 32.
  to change a vulgar fraction to, 14.
  to reduce a decimal to a vulgar fraction, 15.
  addition and subtraction, 15.
  multiplication and division, 15.
DISTILLER,
  licence duties and regulations, 338.
DISTILLATION, process of, 340.
DISTILLERY, utensils to gauge, 101, 185, 188, 192, 198, 208, 212, 217.
DISTRICTS, schemes of, 256.
DIVISION,
  simple, 7.
  compound, 36.
  of vulgar fractions, 12.
  of decimals, 15.
  by the sliding rule, 167.

DIVISION OFFICERS, 250, 256.
DIVISORS,
    table of, for reducing inches into areas, 57.
    circular, to find, 91.
    spherical, to find, 137.
DOUBLE DUTY, penalty of, 289.
DRAWBACK,
    producing goods fraudulently to obtain, 288.
DRIP,
    to measure a vessel with, 207.
DUTIES,
    how charged, 281.
    when payable, 283.
    upon what chargeable, 289.
    how recoverable, 288.
    calculations respecting, 38, 46.
ELLIPTICAL PRISM, 114, 121.
ELLIPTICAL STORE-CASK, to gauge, 195.
ELLIPSIS, 95.
    theorems, 96.
    problems, 97.
    to find the area, 99, 108.
ENTRY OF PLACES AND UTENSILS, 285.
    by whom to be made, 285.
    mode of proving, 285.
EQUIDISTANT ordinates, 101.
EXAMINERS, 252.
EXCISE DUTIES, 279.
    origin of, 279.
    mode of charging, 281.
EXCISE ESTABLISHMENT, 247.
EXPECTANTS, 249.
EXPORTING GOODS on drawback, 287.
EXTENT proceedings on, 289.
FACTORS,
    what, 31.
    how to find, 31, 91, 137.
    table of, for salaries, 49.
    table of, for converting old measure into new, 56.
    table of, for reducing inches into areas, 57.
FOOT-WALK OFFICERS, 250, 256.
FRACTIONS,
    vulgar, 10.
    decimal, 13.
    of a pound sterling, &c., 49, 51, 52, 54.

FRUSTUM of a Prism, 114.
  of a pyramid, 128, 185.
  of a cone, 129, 220, 230, 231.
  of a spheroid, 141, 142, 220, 223, 230, 232.
  of a sphere, 139.
  of a parabolic conoid, 143, 129, 220, 230—231.
  of a parabolic spindle, 146, 220, 230, 235.
GALLONS,
  dimensions of, 28, 54.
  table for converting inches into, 53.
GAUGING, 161.
  open vessels, 182.
  regularly formed vessels, 183.
  vessels whose forms are nearly regular, 187.
  irregular vessels, 198.
  stills, 212.
  casks, 218.
  by callipers, 224.
  tables for, 240.
GAUGE POINTS,
  definition of, 19, 172.
  table of, for reducing inches into areas, 57.
  application of, to the sliding rule, 172.
  table of, for different kinds of vessels, 173.
  diagram of, for the line X, 232.
GENERAL REGULATIONS, for securing excise duty, 279.
GEOMETRICAL,
  mean, 19.
  definitions, 61.
  axioms, 62.
GLASS,
  duties, 300.
  makers, licences, 300.
  drawbacks, 300.
  process of manufacture, 302.
  regulations for charging the duty, 303.
  rules for calculating the duty, 38.
  pot, to gauge, 193, 194.
  circular divisor for, 303.
  specific gravity of, 59.
GUILE TUN to gauge, 195.
HEAD ROD, 225, 230, 231.
HEXAGONAL PRISM, 120.
HOPS,
  duties, 308.
  drawbacks, 309.
  mode of cure, 309.
  regulations for charging the duty, 309.

HYDROMETER, 26.
HYDROSTATIC balance, 26.
HYPERBOLA, 95.
  theorems, 97.
  problems, 97.
  to find the area, 100.
HYPERBOLIC CONOIDS, 144.
IMPERIAL MEASURE, 28.
  dimensions of, 28, 54.
  tables of, 53—56.
INCHES,
  table for converting, into pounds weight, 51.
  table for converting, into gallons, 53.
  table for converting, into bushels, 55.
INCHING CASKS, 239.
INCUMBRANCES,
  to measure vessel with, 208.
INTEREST, 38.
IRREGULAR CURVES,
  to measure by equidistant ordinates, 101.
IRREGULAR PRISM, 114.
  to find the content, 122.
IRREGULAR VESSELS,
  to gauge and tabulate, 198—211.

LICENCED,
  traders to put up their names, 286.
LICENCES,
  general regulations respecting 286.
  duties on, 310.
LINES,
  problems relating to, 64.
LINEAL MEASURE, 28.
  table of, 56.
LONDON ESTABLISHMENT, 274.
LOGARITHMS,
  nature of, 162.
  table of, for Gunter's line, 165.
LUNE,
  to find the area of, 94.

MALT,
  duties, 311.
  drawbacks and allowances, 312.
  process of malting, 313.
  regulations for charging the duty, 314.

MALT, *continued.*
  utensils and floors to gauge, 117, 173, 178, 183, 210.
  tables relating to, 55, 148, 240.

MASH TUN,
  to gauge, 196.

MATHEMATICAL TABLES, 148.
MEASURES, 24.
  tables of, 50—60.
MEASURE OF CAPACITY, 28.
  standard of, 28, 54.
  table of, for ale and beer, 52.
  table of, for wines and spirits, 52.
  table of, for corn and dry goods, 54.
MENSURATION, 61.
  of lines and angles, 62.
  of superficies, 70.
  of solids, 112.
MIXTURES,
  duties on, 337.
MONEY,
  tables of, 48.
MULTIPLICATION,
  simple, 5.
  table, 5.
  compound, 35.
  of vulgar fractions, 12.
  of decimals, 15.
  by the sliding rule, 167.

NONIUS, 66.
NOTATION & NUMERATION, 1.
  rules for, 3, 10, 13, 166, 170.
  table, 2, 13.

OATH of office, 249.
OFFICERS OF EXCISE,
  appointment of, 248.
  salaries of, 251, 253, 254.
  promotion of, 275.
  privileges of, 277.
  stations of, 256—273.
  actions against, 277.
OPEN VESSELS to gauge, 182.
ORDINATES, EQUIDISTANT,
  measuring planes by, 101, 198.
  proposition and demonstration, 102.
  to draw the ordinates, 105.
  to find the area, 107, 200.

ORDER for instructions, 248.
ORIGIN of excise duties, 279.
OVAL, 99.
PAPER,
    duties, 320.
    maker's licences, 320.
    allowances, 320.
    drawbacks, 321.
    process of manufacture, 321.
    regulations for charging the duty, 323.
PARABOLA, 96.
    theorems, and prolbems, 97.
    to find the area, 100.
PARABOLIC CONOID, 140, 143.
PARABOLIC SPINDLE, 140, 144.
PARALLELOGRAM, 78.
    to find the area, 80.
PARALLEL LINES, 66.
    problems relating to, 66.
PARALLELOPIPEDON, 114.
    theorems, 114.
    to find the content, 117.
PARISH APPRENTICES, Officers not liable to take, 277.
PARISH OFFICES, Officers exempted from, 277.
PASSAGE VESSELS,
    licences duties, 325.
PENALTIES,
    prosecutions for recovery of, 288.
PENCE TABLE, 48.
PENTAGONAL PRISM, 120.
PEPPER, 299.
    licence duties, 299.
    excise regulations, 299.
PERMITS,
    general regulations respecting, 286.
PERPENDICULAR LINE to draw, 65.
POLYGONS,
    theorems, 82.
    problems, 82.
POLYGON REGULAR,
    to find the area, 83.
    table for finding the area, 152.
POLYGONS IRREGULAR,
    to find the area, 84.
POST HORSES,
    duties, 326.

POST HORSES, *continued.*
  licences, 327.
  regulations for securing the duty, 327.
POUND'S WEIGHT,
  standard for, 24.
  table for converting inches into, 51.
PRACTICE, rules for, 44—47.
PRICES,
  rules for calculating, 38.
  table of, for hundred-weights and lbs., 50.
PRISMS, 114.
  theorems, 114.
  to find the content, 117.
PRISMOIDS, 131.
  theorems, 131.
  to find the content, 132.
PRIVILEGES of Excise Officers, 277.
PROGRESSION, 22.
  definition and examples, 22.
PROMOTION,
  order of, 275.
PROPORTION,
  simple, or rule of three, 9.
  compound, 37.
  inverse, 43.
  double, 44.
  by the sliding rule, 168.
PROSECUTIONS for recovery of duties and penalties, 288.
PYRAMIDS, 123.
  theorems, 123.
  to find the content, 126.
PYRAMIDICAL UNGULAS, 124.

QUADRILATERALS, 78.
  theorems, 78.
  problems, 79.
  rules for finding the areas, 80.
QUEEN'S share of penalties and forfeitures, 289.

RECTANGLE, to find the area of, 80.
RECTIFIERS, 338.
  licence duties
  excise regulations, 341, 347.
REDUCING SPIRITS,
  calculations for, 26, 43, 242.
REDUCTION, 29.
  to reduce from a greater denomination to a less one, 29.
  to reduce a less denomination to a greater one, 31.

**REDUCTION,** *continued.*
- to reduce a decimal to its proper denomination, 32.
- to reduce a vulgar fraction to a decimal, 14.
- to reduce a decimal to a vulgar fraction, 15.

**REGULAR BODIES,** 147.

**REGULARLY FORMED VESSELS,** 188.

**REQUEST NOTES,** 286.

**RIGHT LINES,** 64.

**ROOTS,**
- and squares, table of, 17.
- and cubes, table of, 19.

**ROUNDS, (COLLECTORS,)** 283.

**RULE OF THREE,** 9, 37, 168.
- double, 44.

**SACCHAROMETER,** 27.

**SALARIES,** 38, 49, 248, 250, 254, 275.

**SCALE** of even parts, to make, 63.

**SCHEMES** of Collections and Districts, 256—273.

**SECTOR** of a circle, 85.
- to find the area, 91.

**SEGMENT,**
- of a sphere, 136.
- to find the content, 138, 186.
- of a spheroid, 140.
- to find the content, 141.
- of a circle, 85.
- to find the area, 92.

**SEMI-SQUARES,**
- table of, 148.
- application of, 80, 119, 152.

**SHIP,** to gauge, 211.

**SIGNS,** explanation of, xii.

**SLIDING RULE,** 161.
- description of, 161.
- of the lines, A, and B, 162.
- to estimate the value of the numbers, 166.
- to multiply given numbers, 167.
- to divide given numbers, 167.
- to perform the rule of three, 168.
- to find the areas of squares, circles, &c., 168.
- of the lines C, and D, 169.
- to estimate the value of the numbers, 170.
- to square any given numbers, 170.
- to extract the square root, 170.
- to find a mean proportional, 171.
- to find a proportional to squares, 171.
- to find a proportional to roots, 171.

SLIDING RULE, *continued.*
  to cube a given number, 172.
  to extract the cube root, 172.
  of gauge points, 172.
  to find the area and contents by, 118, 174, 175.
  of the line M D, 176.
  to find the area and contents by, 118, 178.
  circular, 177.
  of the line X, 179.
  to find the content of a cask by, 179, 231, 232.
  of the variety lines, 180.
  of the ullage lines, 180.
  to ullage a cask by, 181, 236.
SNUFF,
  makers, and dealers licences, 350.
SOAP,
  duties, 328.
  makers licences, 329.
  drawbacks, 329.
  allowances, 329.
  process of manufacture, 330.
  regulations for securing the duty, 331.
  frame to gauge, 184, 332.
  specific gravity of, 59, 332.
SOLID measure, 27.
  table of, 57.
SPECIFIC GRAVITY.
  nature of, 25.
  rules for calculating, 40.
  table of, 59.
SPHERE, 136.
  theorems, 136.
  to find the content, 137.
SPHEROIDS, 140.
  theorems, 140.
  to find the content, 141.
  frustums of 141, 142, 220, 223, 230, 232, 234.
SPIRITS,
  duties, 335.
  licences, 338.
  allowances and drawbacks, 339.
  process of distillation, &c., 340.
  regulations for securing the duty, 342.
  rules for averaging and compounding, 26, 41, 242.
  receiver, to gauge, 188, 199, 208.
  store vat, to gauge, 185, 192.
  still, to gauge, 212.
  table shewing the quantity of water necessary to reduce proof spirits to other strengths, 242.

**SPIRITS**, *continued.*
  table shewing the quantity of water necessary to reduce spirits of 22 per cent., u. p. to other strengths, 242.
  table shewing the quantity of spirits of 22 u. p., to be added to spirits of 61, u. p. 242.

**SPINDLES,**
  parabolic, 140, 144.
  circular, 140, 144.

**SQUARE VESSEL**, to find the content, 80, 117.

**SQUARE**, to find the area of, 80.

**SQUARE PYRAMID**, to find the content, 126.

**SQUARE ROOT,**
  explanation of, 16.
  rules and examples in, 18, 80, 170.
  application of, in finding a geometrical mean, 19, 118, 171.
  application of, in finding gauge points, 19, 172.

**STANDARD** weights, 24.
  measures, 27.

**STERLING MONEY**, table of, 48.

**STILLS,**
  description of, 212, 341.
  to gauge the body of a large still, 213.
  to gauge the body of a small still, 215.
  to gauge a still head, 217.

**STRENGTH** of spirits,
  to calculate, 26, 41.

**SUBTRACTION,**
  simple, 4.
  compound, 34.

**SUGAR,**
  duties on, 296, 350.

**SUPERFICIAL MEASURE**, 28, 56, 70.
  theorems relating to, 70.

**SUPERANNUATION** deductions and allowances, 278.

**SUPERNUMERARIES**, 250.

**SUPERVISORS**, 253.

**SURVEYING DEPARTMENT,**
  peculiarities of, 248.
  different ranks of officers in, 248—274.
  distribution of the country business, 256—273.
  general course of charging the duty, 281.

**SURVEYING GENERAL EXAMINERS**, 254.

**SURVEYING OFFICERS**, 250.

**SWEETS,**
  licences, 350.
  excise regulations, 350.

TABLES, list of, xii.
TEA,
    licence duties, 299.
TIME, 24, 29, 58.
TOBACCO AND SNUFF,
    manufacturers' licences, 350.
    dealers' licences, 351.
    excise regulations, 351.
TRAPEZOID, to find the area of, 80.
TRAPEZIUM, to find the area of, 81.
TRIANGULAR PRISM, 114.
    to find the content, 119.
TRIANGLES, 72.
    theorems, &c., 72.
    problems, 74.
    to find the area, 75.
TRIGONOMETRY, 74.
ULLAGE line, 180.
    rule, 180, 237, 239.
ULLAGING, 180, 236.
UNENTERED MANUFACTORIES, 285.
UNGULAS, 124, 125.
VARIETY LINE, 180, 233.
VERNIER, 66.
VINEGAR,
    duties, 352.
    makers licences, 352.
    process of manufacture, 352.
    regulations for securing the duty, 353.
VOUCHER,
    form of (but see Board's Order, of July 7, 1840), 283.
WEDGE, 131.
    theorems, 131,
    to find the content, 135.
WEIGHTS and measures, 24.
    acts relating to, 25, 28.
    tables of 50—60.
WINE,
    dealers licences, 354.
    excise regulations, 354.
X line, 179, 232,
ZONE of a sphere, 139.
    of a spheroid, 142.

---

W. Cock & W. F. Jackson, Printers, Woolwich.

# WORKS BY J. BATEMAN.

*Published by Maxwell, Bell-Yard, and S. Cock.*

---

## I.

## A PRACTICAL TREATISE
ON THE
## LAW OF AUCTIONS;

**With Forms, Tables, Statutes, and Cases, and Directions to Auctioneers;**
Price 7*s.* 6*d.*

"This is a work, than which one more creditable to the learning, perspicuity, and zeal of the Author, whoever he may be, [it was published anonymously] cannot well be conceived."—*Monthly Law Magazine*, 1838.

"The Law of Auctions on which a practical Treatise has just been published, ought to be in the hands of every one conducting Sales by Auction. The "Law of Auctions" has appended to it copious appendices of forms in use in practice, and of statutes and reported cases relative to Auctions; and contains, in short, all the information necessary to the correct management of the business of an Auctioneer, and the avoidance of the heavy penalties any infringement of the excise regulations imposes."—*Tait's Magazine, for June*, 1838.

"No description of books have proved more generally useful than those which have brought together, embodied and concentrated, all the loose and scattered laws that have, from time to time, been enacted on particular subjects. As regards the mere citizen, to whom some knowledge of law is essential, particularly on certain points, if he would avoid the many stumbling-blocks which beset his path, it is utterly impossible for him to make himself acquainted with written law by the aid of the statute books. Suppose, for instance, he wished to learn something of the law of auctions; where would he search for information unless he had some such treatise as the one before us? To lawyers, of all classes, such works are invaluable: their direct effect is to save much valuable time and laborious study. Much of the information presented in the book under consideration, for instance, is condensed into tables, in which, at a glance, many valuable particulars may be learned; while cases are given sufficient to furnish the attorney or advocate with precedents bearing upon any matter that may come under consideration. We imagine we need scarcely dwell upon the utility of digests of laws to those engaged in the particular avocations for the regulation of which such laws have been framed. To the lawyer a work of this sort must be useful: to the trader, it is essential. We need scarcely, therefore, recommend the work to the attention of auctioneers. Not the least of its recommendations is the very popular manner in which it is written. We may safely venture to affirm, that there is no class of the community who could read it without being interested and instructed. It is hardly possible to conceive, that so much novel and pleasing information could be mixed up with a disquisition on the law of auctions, and we must give the author credit for having so well handled so dry a subject."—*Liverpool Albion, Nov.* 5, 1838.

"This is a comprehensive and clear view of the laws, duties, liabilities and practice of auctioneers, and of all that relates to sales by auction. It makes a proper distinction between our laws upon the subject, as far as they are merely acts of revenue, or statutes to enforce the integrity of *bona fide* transactions, and to facilitate this mode of disposing of property. The work is the auctioneer's *vade mecum*, and is drawn up with skill and learning. Its distinctions are accurate and well applied."—*Weekly Dispatch, April*, 1, 1838.

"This is a very useful book, and should be in the possession of every auctioneer in the kingdom. It is a manual of directions to assist him in the skilful exercise of his trade or business. It contains directions for the description of every species of property, and for preparing the particulars and conditions of every variety of real and personal estate. It contains also the laws of bidding, sale, and deposit; the forms of returns to be made to the Excise; the modes of enforcing or annuling the contract; and the auctioneer's responsibility for the proceeds of the sales, &c."—*Bell's Messenger, March* 25, 1838.

# WORKS BY J. BATEMAN.

*Published by Maxwell, Bell-Yard, and S. Cock.*

---

## II.

## THE GENERAL TURNPIKE ROAD ACTS,

**With Notes, Forms, and an Index.**

**By J. Bateman, Esq., of Lincoln's Inn.**

**The Third Edition. Revised and considerably enlarged, and the Statutes brought down to the present time. 12mo.**

**Price 9s. boards, with Plates.**

**This is the only complete work upon the above important branch of Domestic Legislature; and contains—in addition to the whole of the Statutes, which have been reprinted and brought down to the present time—numerous Practical forms; an Appendix of Cases, including several recent decisions upon Tolls, the responsibility of Trustees, Repairs, &c.; Standing Orders of Parliament respecting Private Bills; Report of the Select Committee of the House of Lords, relating to the Consolidation Turnpike Trusts; Rules for repairing Roads, &c. &c.**

---

## III.

## THE GENERAL HIGHWAY ACT,

**5 & 6 WILL. IV. c. 50,**

**With Notes, Forms, and Index.**

**By J. Bateman, Esq., Editor of the Turnpike-Road Acts, &c.**

**Together with Appendix, containing**
**Statutes and part of Statutes referred to in the Act;**
**Alphabetical List of Persons to be rated;**
**Table or Calculation for regulating Team-work;**
**General Rules for repairing Roads, issued by the Parliamentary Commissioners of the Holyhead Roads, &c.**

**Price 5s. boards, with Plates.**

**"It is gratifying to see any approach towards 'codification;' and we may hope, that by one consolidated act after another, much may be done towards reducing the number, simplifying the style, and harmonising the provisions of the laws under which we live. Mr. Bateman is a very useful interpreter between the legislature and the public; and his publication may interest us about mending our ways in more senses than one."—*Monthly Repository.***

---

## IV.

## METROPOLITAN TURNPIKE ACT;

**The Statute 7 GEO. IV., c. 142.**

**For consolidating the Trusts of the Turnpike-Roads in the neighbourhood of the Metropolis, North of the Thames. With Notes, and a Digested Index. By the Editor of the General Turnpike Acts. 12mo. 5s. 6d. boards.**

# WORKS BY J. BATEMAN.

*Published by Maxwell, Bell-Yard, and S. Cock.*

---

## V.

## THE EXCISE OFFICER'S MANUAL;

OR

**Improved Practical Gauger.**

BEING A

COMPENDIOUS INTRODUCTION

TO THE BUSINESS OF CHARGING AND COLLECTING THE

DUTIES OF EXCISE.

Price 7*s.* 6*d.* boards.

**This work contains an account of the Excise Establishment; the Duties, Drawbacks and Allowances under the management of the Excise, corrected to the present time; an account of the processes of manufactures of various excisable articles; an abridgment of the legal regulations for charging and securing the duty; scheme of every collection and district in the United Kingdom; and extracts from the Reports on the Excise Enquiry. With numerous Tables, Forms and Instructions. Also the whole act of Gauging; illustrated with above 200 Wood and Copperplate Engravings.**

---

## VI.

## THE GENERAL LAWS

RELATING TO THE

## REVENUE OF EXCISE;

VIZ.:

General Regulations, Duties, Licences, and Permits.

Price 3*s.* extra bds.

**This work is not an abridgement, as from its portability might be supposed. It contains a verbatim copy of the Acts of Parliament most frequently referred to in Excise matters, with the repealed and altered parts, carefully marked, and a copious index, &c. Until the new Edition of Huie's Excise Laws is ready, this work will serve in many cases as a substitute for it, with the additional advantage of being printed in the very words of the Legislature. It is closely printedfor the pocket, and to secure an extensive sale, is published at a very moderate price.**

A New Edition is in the Press.

---

## VII.

PRECEDENTS OF

## PRIVATE ACTS OF PARLIAMENT,

Selected and Approved by

A COMMITTEE OF THE HOUSE OF LORDS,

**With Additional Forms, Variations, and Notes, adapted to all the usual circumstances of Local and Private Legislation.** *Very Thick.* **8vo** *Closely Printed.* **1*l.* 4*s.* boards.**

**" The precedents are divided into classes, according to the arrangement adopted in a work entitled, *Practical Instructions on the passing of Private Bills through both Houses of Parliament;* such arrangement having regard not so much to the different objects contemplated by the Bills, as to the orders in Parliament under which they are introduced. The additional forms and variations, which are distinguished from the approved Precedents, are printed in a smaller type. and have been selected from Drafts or Forms of actual practice, the names of which are in many cases stated as they occur."**

# S. COCK,

OF THE

# EXCISE STORE OFFICE,

**Continues to supply Supervisors and Officers with Guaging Instruments, &c., in the same manner as has been done by himself and his predecessors, Mr. Ilston, &c. from time immemorial.**

---

## A List of Articles usually required by Officers on their first appointment.

1 Excise Officer's Sliding Rule
1 Box and Tape
1 Malt Stick
1 Dimension Cane and Brannans
1 Diameter Rule
1 Spile Rod and Gimlet
1 Malt Plate and Receiver
1 Dipper
1 Excise Officer's Manual
1 General Laws of Excise.

---

## THE FOLLOWING ARE REQUIRED ACCORDING TO CIRCUMSTANCES.

Walking Cane, containing a 36 inch Guaging Rod
Victuallers' Rules
Ditto Floats
Head and Bung Rods
Gauging Callipers
Ticklers
Gimlets and Cases
Stave Gauges
Ink Bottles
Soap Gauges
Cases of Magnifying Glasses
Ullage Rules
Ditto Floats

---

## TRADERS AND OFFICERS ARE SUPPLIED WITH ANY OF THE FOLLOWING INSTRUMENTS, &c.

Sikes's Hydrometer, made by J. B. Bates, Esq., with *Book of Instructions* and Proof Glass complete.
Ditto ditto, made by Mr. J. Long, with ditto ditto
Accetometer for trying the strength of Vinegar
Saccharometers by Bates, Long, Richardson, Clark, &c., with Tables, and Directions complete.
Proof and Reducing Rules
Apparatus for ascertaining the quantity of Alcohol in Wine, &c.
Instrument for ascertaing the degree of concentration produced by the admixture of Liquids.
Glass Outer Indexes, (commonly called Tell Tales) to shew the quantity of Liquor in Vats and Casks, without dipping.
Imperial Chondrometers, for weighing Corn, Malt, &c
Improved Brewing Thermometers of every description
Folding and Dip Rules
Beads and Bubbles
Ticklers
Brewers' Gimlets
Brewers' Floats of every description
Proof Glasses
Malt Sticks, Plain and Screw.
Sample Drawers.

Instruments Repaired and re-adjusted.

---

## BOOKS.

Excise Officer's Manual
Auction Laws
General Laws of Excise, 2nd edition
Acts of Parliament
Morewoods' Distillery
Proof Tables
Reports of Excise Enquiry
Treatise on Malting and Brewing
Cunningham's Ullager
Roose's ditto
Wallace's Commercial Book-keepg.
Index of General Orders, &c.

A new Edition of Huies' Abridgement is in preparation

DESCRIPTION AND USE

OF

# SIKES'S HYDROMETER,

AND

# Long's New Improved Saccharometer,

AND OF VARIOUS

# TABLES AND RULES,

FOR ASCERTAINING THE STRENGTH OF, REDUCING, COMPARING, AND COMPOUNDING SPIRITS AND FERMENTED LIQUORS.

---

MADE BY

## JOSEPH LONG,

AND SOLD

By S. COCK.

---

LONDON:

PRINTED FOR THE MANUFACTURER,

By W. Cock and W. F. Jackson, Green's End, Woolwich.

*N. B. Hydrometers and Saccharometers made by* J. LONG *are covered with a body of fine Gold, thereby preventing the Instrument from corroding and wearing light, and consequently remaining in a fit state of adjustment for a very long period.*

# DESCRIPTION AND USE OF

# SIKES'S HYDROMETER,

### MADE BY JOSEPH LONG, AND SOLD BY S. COCK.

SIKES'S HYDROMETER consists of a spherical ball, with an upper and a lower stem; to the latter is attached a poise weight, to keep the instrument upright when floating in the spirit; the upper stem is a flat square or parallelogram divided on two sides into ten principal divisions, numbered 0 to 10, and again subdivided into 5ths of divisions. There are nine weights, numbered progressively, from 10 to 90, each weight being equal to the ten divisions on the stem, and will sink the instrument the whole ten divisions deeper than the preceding weight; the whole instrument is therefore divided into 100 principal divisions, and again subdivided into 5ths, making a total of 500 divisions or points of strength, at each degree of temperature; and as the tables or rules which accompany the instrument are calculated to show the strength at every degree from 30 to 80 inclusive, being 51 degrees; the whole range of judications or points of strength, are 25500. It must be observed that not more than one weight is to be put on the instrument at once. If it is too heavy it must be removed and a lighter one put on, and the reverse if it is too light. The extent of strength of spirits found by the hydrometer is from water to 69 per cent. over proof or specific gravity ·8156, taking water at 10,000. The instrument is fitted up in a neat case, with a thermometer to ascertain the temperature; and also rules, if required, for showing the strength and comparative value of spirits, &c.

For warm climates where the temperature is seldom under 80 degrees, tables and rules are calculated extending the temperature to 100 degrees.

J. Long also makes Sikes's Hydrometer with the weights fitted to the top: by this method the weights are not immersed in the spirits, consequently corrosion is prevented, and the necessity of wiping them after using is obviated.

A small Sikes's Hydrometer for proving the strength of so small a quantity as a wine-glassfull of spirit, with equal facility and accuracy as those of the usual size.

J. L. was induced to construct this instrument, in consequence of the frequent complaints of the difficulty of ascertaining the strength of samples; which by frequent tasting and trying had been so reduced in quantity as to render the usual sized Hydrometer quite useless for that purpose.

# THE USE OF THE TABLES,

## FOR ASCERTAINING THE CONCENTRATED STRENGTH OF SPIRITUOUS LIQUORS.

These tables are constructed so that each opening is a table comprising all the strengths from water to the strongost spirit that can be proved by the Hydrometer, at the degree of temperature mentioned at the top of each page, beginning at 30° and ending at 80° by Farenheit's Thermometer.

In the columns marked "Weights and Divisions on Stem," the numbers 10, 20, 30, &c., at the top, answer to the numbers on the weights. The numbers down the columns, under the respective weights, represent the number on the stem of the Hydrometer, added to the weights; and the single numbers .2, .4, .6,.8, &c., are tenths of divisions on the stem. See plate, fig. 2.

First pour a sample of the spirits intended to be tried in the Trial Glass; immerse the Thermometer, and note at what degree the quicksilver becomes stationary, which is the temperature of the spirits. Open the book of Tables at that same degree of temperature; then put a weight on the lower stem of the Hydrometer, and immerse it in the spirits, gently pressing it down to 0 on the stem: if it is right weight, it will float to some division on the upper stem; note the division and add it to the weight applied, which is the Hydrometer weight of the spirits; then look in the Table under the degree of temperature which the spirit is, for the number of the weight at the top of the column; look down that column for the division it floated to on the stem, facing which in the next column is the strength of the spirits. If the weight applied will not float the Hydrometer to 10 on the stem, it must be removed and a heavier weight applied; if it floats deeper than 0 on the stem, a lighter weight must be applied.

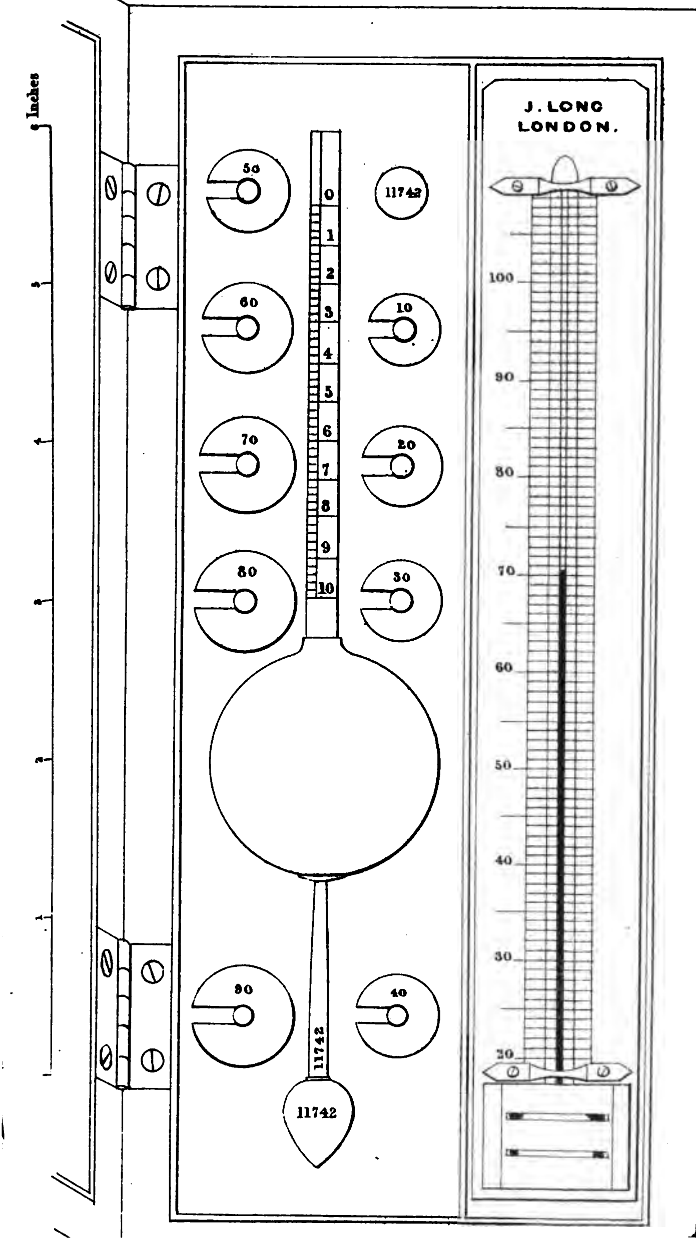
### EXAMPLES.

Suppose, in 64 degrees of temperature, the Hydrometer, with the weight 30 on the bottom, sinks to 5 on the stem, the weight of the spirit is 35; then having found the table for temperature 64°, look down the column for 35, the Weight and Division on stem: directly opposite will be found 31 per cent. over proof: if the Hydrometer, without a weight, sinks to 7 on the stem, the weight becomes 7; then look in the column for 0; having found it, carry the eye down the column till it comes to 7, opposite to which will be found 60 per cent. over proof, &c., &c.

If in 50o of temperature, the Hydrometer with the weight 60 on the bottom, sinks to 6 on the stem, find the table for temperature 50, and having found 66 the weight and division, directly opposite will be found 8.1, which is 8 per cent. and one-tenth under proof.

The lines dividing the columns, as at 61, shew a spirit of that strength to be proof, therefore all strengths preceding those lines are over proof, and those succeeding under proof, as may be seen at the top of each table. The cap weight which goes on the top stem of the Hydrometer, shews the difference between water and proof spirit, as described in the first clause of the Hydrometer Act, and if applied on the top, with the weight 60 on the bottom, will sink the Hydrometer in distilled water to the proof point on the edge of the stem at 51° of heat, the weight 60 sinking it to the same division in proof spirit at that degree of temperature.

FIG. 2.



Inches
11742
11742
11742
J. LONG
LONDON.

# OF THE USE OF THE SLIDING RULE FOR ASCERTAINING THE STRENGTH OF SPIRITS.

As the tables which accompany the Hydrometer are too large to be conveniently carried with the instrument at all times, and a Rule is found to answer most purposes equally as well, it is thought advisable to give directions for the use of the Hydrometer and Rule, which will obviate the necessity of having both Tables and Rule. It has only the most general commercial strengths graduated on it, viz. from 33 per cent. under proof to 54 per cent. over proof, although some are made with all the strengths on them.

The Rule here described is generally fitted in the case with the Hydrometer, and is made either of ivory or box wood.

The divisions on the stock, both top and bottom (on one side) are all over-proof, on the bottom from 2 to 33 per cent., and on the top from 26 to 54 per cent. over proof. On the reverse side of the upper stock is graduated from 10 per cent. over proof to 25 under proof; and on the lower stock on the right, from 16 to 33 per cent. under proof. On the left of the lower stock is the scale for regulating the temperature, marked Thermometer Scale, and graduated from 30 to 80.

The slide on both sides of the Rule contains the weights and divisions corresponding to the weight applied to the Hydrometer and the division on the stem, to which the instrument sinks in the spirit under trial; the shortest divisions corresponding to the 5ths of whole divisions on the stem, &c.

## GENERAL INSTRUCTIONS.

First pour a sample of the spirit intended to be tried, in the trial glass; then find the temperature of the spirit by immersing the the Thermometer therein, and note at what degree the quicksilver becomes stationery: and fix the Sliding Rule so that the fleur-de-lis, or index, shall be opposite the same degree on the Thermometer Scale, which the quicksilver rises or falls to.

Then put a weight on the lower stem of the Hydrometer, and immerse it in the spirit, gently pressing it down to 0 on the stem; if it is too heavy or too light, remove it and apply another weight that will cause the instrument to float to some division on the upper stem; note the division, and add it to the weight applied, which is the Hydrometer weight of the spirit; then look upon the middle or sliding part of the Rule for that same weight and division, and directly opposite thereto (on the stock) will be found the exact strength of the spirit.

## EXAMPLES.

Suppose, in 64 degrees of heat, with the weight 30 on the bottom, the Hydrometer sinks to 5 upon the stem; the Rule being fixed so that the fleur-de-lis shall be opposite 64 degrees on the Thermometer scale; then facing 35 will be found 31, which is the number of gallons in the 100 the spirit is above proof: if in 50 degrees of heat, the Hydrometer, with the weight 70 on the bottom, sinks to 2 on the stem, the weight is 72; the Rule being fixed so that the fleur-de-lis shall be opposite 50 degrees of the Thermometer Scale, then facing 72 will be found 18.9, which is the number of gallons in the 100 the spirit is under proof.

## USE OF THE COMPARATIVE RULE,

*Shewing the relative Value of Spirits, and for taking Stocks, and Reducing Spirits from one Strength to another.*

This Rule shews on the side A B, the comparative value of Spirits; and on the side C C C, the quantity of water requisite for reducing from one strength to another. Upon the middle, or sliding part, the different strengths, from 70 per cent. under proof to 70 per cent. over proof, are laid down; and upon the side which shews the comparative value, the line A denotes shillings and pence per gallon, from forty-two shillings to eight shillings per gallon, and the line B from eight shilling to one shilling and sixpence per gallon. The left of proof on this Rule is under proof, and the right is over proof.

EXAMPLES.

Suppose a spirit 20 per cent. over proof, worth eighteen shillings per gallon, place the slide so that 20 per cent. over proof shall be facing eighteen shillings upon the line A, then opposite every other strength will be found the value in proportion thereto; proof will be worth fifteen shillings per gallon; 10 per cent. under proof thirteen shillings and sixpence per gallon. Again, suppose 10 per cent. over proof worth twelve shillings and sixpence per gallon, place the slide so that 10 per cent. over proof shall be facing twelve shillings and sixpence upon the line A, then the comparative value of proof will be eleven shillings and fourpence-halfpenny per gallon; 10 per cent. under proof ten shillings and twopence three farthings; 20 per cent. under proof nine shillings and one penny per gallon. On the line B, if proof spirit cost five shillings per gallon, then 20 per cent. under proof will be worth four shillings per gallons, &c. &c.

On the other side the lines C C, divided upon the upper part from 300 to 60, and below from 100 to 20, denote gallons, to facilitate the reducing of spirits. As an example, if 130 gallons of spirits, 40 per cent. over proof is required to be reduced to proof, place the slide so that 40 per cent. over proof shall be opposite 130 upon the upper line C, then facing proof upon the same line, will be found 182, the number of gallons it is to be made up to. If 100 gallons of spirits, 20 per cent. over proof, is to be reduced 20 per cent. under, fix the Rule so that 20 per cent. over proof shall be opposite 100, then facing 20 per cent. under proof will be found 150, the quantity required. Again, if a cask of 120 gallons is to be filled with a spirit 30 per cent. under proof, place 30 per cent. under proof opposite 120, then the number of gallons of any superior strength requisite to be put into the cask is immediately shewn by inspection. If the spirits are 10 per cent. under proof, facing 10 per cent. under, will be found 93 gallons and one-third, the quantity required; if the spirits are proof, opposite proof will be found 84 gallons, the quantity requisite; if 20 per cent. over proof, 70 will be the quantity of spirits, &c., the remainder to be made up with water.

By this side of the Rule stocks may be taken and charges estimated, by placing the strength opposite the quantity; then opposite the strength the stock is to be taken at, will be found the exact quantity of such spirit.

# DESCRIPTION AND USE

# OF

# LONGS'S

# NEW

# IMPROVED SACCHAROMETER,

Sold by S. Cock.

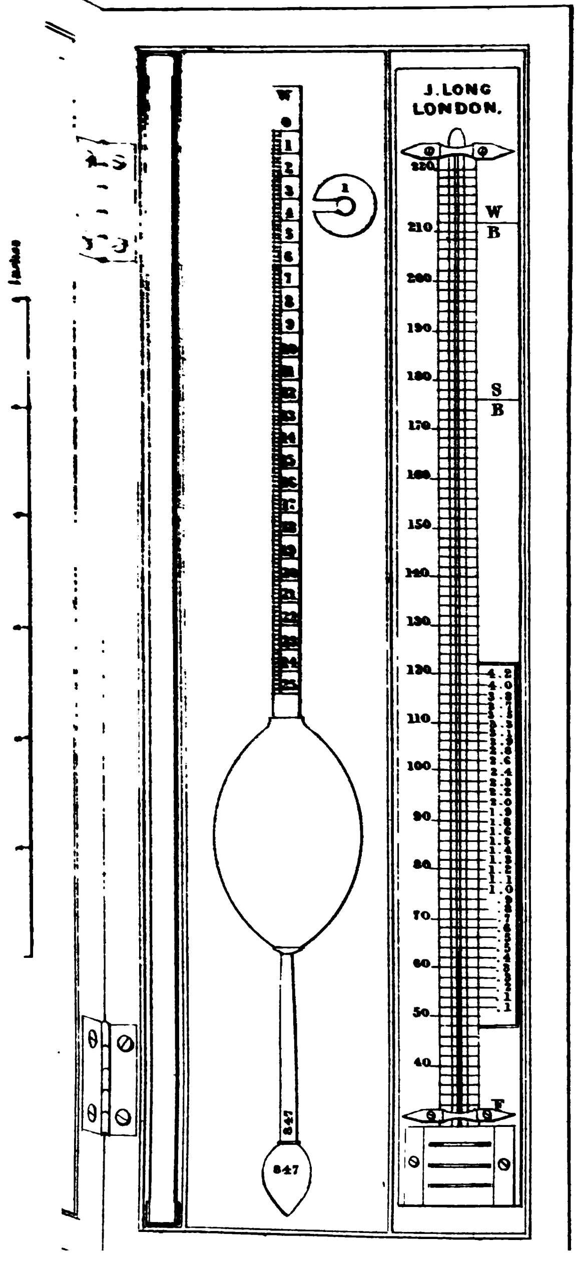
The Saccharometer consists of an oval ball, with the upper stem divided on two sides, each comprising a range of twenty-five principal divisions, and again subdivided into fifths, answering to pounds and fifths of pounds per barrel. The first side engraved O. W. extends from water to 25lbs. per barrel, and it is to be attended to without a weight being fixed to the bottom stem; the reserve side engraved No. 1, is used with the No. 1 weight, fixed to the bottom stem; and extends from 25lbs to 52lbs. per barrel. A wort that floats the instrument to 25 on the O. W. side of the stem, will, with the addition of the weight No. 1, sink it to 25 on the No. 1 side of the stem. Previous to using the Saccharometer, it is requisite to adjust it to the water that is to be used in brewing, as water in different situations varies in density; to adjust which, obtain some of the water that is to be employed, try its heat by the Thermometer, and then immerse the Saccharometer. Should the heat be just 50 degrees, and the Saccharometer sink to O. W. on the stem, its adjustment is sufficiently correct. If it does not sink to that point, gently unscrew the bottom poise weight, and put in the vacuity thereof as many of the small leaden pellets (which are sent with the instrument for that purpose) as may be requisite to sink it to its standard point, occasionally raising or depressing it until it becomes stationary at O. W.; when it remains stationary at that point, the instrument is properly adjusted, and is the true standard of all future comparisons.

In adjusting the instrument during the summer months, the coldest state possible the water can be obtained, will exceed 50 degrees: try the heat, and for every 5 degrees that the water is warmer than 50 degrees, suffer the instrument to sink one of the divisions on the edge of the stem deeper than O. W., as the standard heat that the instrument is adjusted to, is 50 degrees of temperature with the New River water.

The Thermometer is constructed so as to act in unison with the Saccharometer, by allowing for the expansion of worts occasioned by heat, thereby serving the purposes of a Rule or Table for general use. But as worts of different strengths vary in their expansion, it is requisite to have a Rule or Tables to shew the exact strengths at any very high degree of heat or strength, more particularly when minute accuracy is required; for that purpose there is a Rule with the Expansion Scale graduated from 50 to 150 degrees of heat, and from water to 60lbs. per barrel of gravity of 156lbs. of real extract per barrel; likewise a line of comparison, shewing what any number of pounds gravity per barrel are equal to in extract per barrel, for the convenience of those who are in the habit of using instruments which only shew extract or gravity per barrel.

By the term gravity, is understood that the barrel of worts is that number of pounds (which the instrument indicates) heavier than a barrel of water, not allowing for the quantity of water displaced by the introduction of the saccharine matter; by the extract is understood, that there are that number of pounds of saccharine or fermentable matter (which the instrument indicates) contained in a barrel of that wort, allowing for the quantity of water displaced by the introduction of the saccharine matter, each pound whereof occupies the space of 0.6154 parts of a gallon of water. A wort of 20lbs. per barrel gravity, contains 52lbs. of extract, or solid fermentable matter, consequently each pound of gravity that the barrel is heavier than water, contains 2.6lbs. of saccharine or solid extract. A barrel, or 36 imperial gallons of water, weighs 360lbs., and a barrel of wort of 20lbs. gravity, weighs 380, being 20 additional for the wort, and contains 52lbs. of solid extract or fermentable matter, which at .06154 parts of a gallon for each pound, occupies the space of 3.2 gallons of the liquid, leaving 32.8 gallons of water, the weight whereof at 10lbs. per gallon, amounts to 328lbs., to which, adding the extract 52lbs., make the total amount of weight 380lbs., the weight of a barrel of wort of 20lbs. gravity; thus clearly demonstrating, that each degree of gravity of pounds per barrel heavier than water contains 2.6lbs. of saccharine matter, and that each pound of extract occupies .06154 parts of a gallon in measure, and displaces that quantity of water per gallon. The Saccharometer, with the assistance of the Thermometer, is sufficiently accurate for most general purposes, as the expansion of worts which occur at the various heats are noted on the Thermometer Scale, facing the respective degrees of heat at which such expansion takes place at a medium degree of gravity, viz. 20lbs., consequently the nearer the sample under trial approaches to that strength, the more correct will be the result; but the variations under that strength in no case will amount to more than 2-10ths of a pound, even down to water; and above 20lbs. the variations will be very little more; and should the temperature be below 100 degrees, the variations will be considerably less; but in all cases, if more minute accuracy is required, by referring to the A B side of the Sliding Rule, the real strength can be found at any degree of gravity and temperature under 150 degrees. On the reverse side of the Rule are laid down a line of barrels with an appropriate line of gravities, by which the brewer is enabled to regulate his lengths, and produce uniformity of strength from a superior or inferior Malt. Likewise a line of shillings per quarter, for estimating the value of Malt according to the strength produced, whereby the brewer is enabled to ascertain the value of Malt, as well by sample as brewing.

FIG. 1.



LONG'S NEW IMPROVED SACCHAROMETER.

# DIRECTIONS FOR USING THE SACCHAROMETER.

First fill the assay jar with the worts intended to be tried, immerse the Thermometer, and note the degree at which the stem becomes level with the surface of the wort; add the number which is facing whatever degree of heat the quicksilver becomes stationed at, to that number on the stem which is level with the wort, and both added together is the strength of the wort or gravity per barrel. If using the Rule, observe at what degree the quicksilver is stationed at, and note what division on the stem is level with the surface of the wort. Slide the Rule on the A.B. side, so that the same degree (which the quicksilver rests at) on the sliding part of the Rule marked temperature scale, be placed opposite the degree of strength (at which the instrument sinks to) ou the stock of the Rule, and facing 50 degrees on the slide will be found its real strength or gravity per barrel on the stock.

## EXAMPLES.

Suppose on immersing the Thermometer the quicksilver rise to 90, and by immersiug the Saccharometer, it rests at 21 and two short divisions below, which will be 21 and $4^{10ths}$; then facing 90 degrees on the Thermometer will be found 1.8, which, added to 21.4, gives $23,2^{10ths}$ pound gravity per barrel. By the Rule, and the foregoing example, place 90 on the sliding part of the Rule marked temperature scale, facing 21.4 on the stock; then facing 50 on the slide will be found 23.2 on the stock, the same as by the Thermometer.

Suppose on immersing the Thermometer, the quicksilver rise to 112, and by immersing the Saccharometer with the weight No. 1 fixed on the bottom stem, it sinks to 33 on the No. 1 side of the top stem; then facing 112 on the Thermometer is 3.5, which added to 33, the number on the stem, gives 36.5, the strength or gravity per barrel. By the Rule, and the foregoing example, place 112 on the slide facing 33 on the stock, then facing 50 on the slide will be found 36.6 on the the stock, the real strength or gravity per barrel, being only the variation of one-tenth of a pound from the example by the Thermometer, which clearly proves that the Saccharometer, with the assistance of the Thermometer alone, is sufficiently accurate for most purposes, without referring to the Rule.

Immerse the Thermometer, suppose the quicksilver rise 132 degress. Immerse the Saccharometer, suppose with the weight

No. 1 it sinks to 44 610ths on the No. 1 side of the stem; slide the Rule so that 132 on the slide be opposite 44.6 on the stock, then facing 50 degrees on the slide will be found 50.7 on the stock, the real strength or gravity per barrel, &c. &c.—See the plate, fig. 1.

---

J. L. also makes Richardson's Improved Saccharometer with only 4 weights, showing 5 lbs. on the stem, the original having 8 weights, and only showing 1 lb. in the stem.

Long's improved Gravimeters, for showing the specific gravity of all fluids lighter and heavier than water from specific gravity 800 to 1500.

Dicas's Hydrometers and Saccharometer.

The whole of the above instruments are covered with a body of fine gold, that not only prevents corrosion but causes them to remain in a correct state for a much longer period; thereby preventing the inconvenience, and saving the expence of so frequent a readjustment which is much complained of by those who use the ungilt instruments.

---

J. L. also manufactures Chrondrometers, for ascertaining the weight per bushel of every description of grain by sample; likewise Gravimeters for showing the specific gravity of Fluids, for Chemists, Soap Makers, Dyers, Tanners, &c.—Also,

Ashton's Patent Hydrometer
Dicas's Hydrometer
Still Hydrometers
Saccharometers for Brewing, on very improved principles
Swan's Barktrometer
Do. Wine Test
Lactometers for Farmers, Graziers, and Dairymen
Saccharometer for Sugar Bakers
Brewing Thermometers of every description
Thermometers for Botanical and Chemical purposes
Ditto Pocket and Ornamental
Barometers of every description
Proof Phials and Bubbles
Improved Self-acting Pegs
Imperial Equalization Rules
Palmer's Wine and Spirit Dealers' Directory
Swan's Treatise on Tanning
Ashton's Spirit Tables
Gutteridge's Tables
Imperial Copper Measures, from half-Quartern to five Gallons
Imperial Pewter Measures for Spirits or Beer.

And every description of Mathematical, Philosophical, and Optical Instruments, wholesale, retail, and for exportation.

ANNO QUINQUAGESIMO OCTAVO

# GEORGII III. REGIS.

---

## CAP. XXVIII.

*An Act to repeal an Act made in the Fifty-sixth Year of His present Majesty's Reign, for establishing the Use of an Hydrometer called* SIKES'S *Hydrometer, in ascertaining the Strength of Spirits, instead of* CLARKE'S *Hydrometer; and for making other Provisions in lieu thereof.*

[23*d May*, 1818.]

WHEREAS a certain Act was made in the Fifty-sixth Year of the Reign of His present Majesty, for establishing the Use of an Hydrometer, called *Sikes's* Hydrometer, in ascertaining the strength of Spirits, instead of *Clarke's* Hydrometer; reciting therein; that by an Act made in the Forty-first Year of the Reign of His present Majesty, among other things, for making perpetual so much of an Act made in the Twenty-seventh Year of the Reign of His present Majesty, as related to ascertaining the Strength of Spirits by *Clarke's* Hydrometer, it was enacted, that so much of an Act made in the Twenty-seventh Year of the Reign of His present Majesty, intituled, *An Act for making Allowances to the Dealers in Foreign Wines for the stock of certain Foreign Wines in their Possession at a certain Time, upon which the Duties on Importation have been paid, and for amending several Laws relative to the Revenue of Excise*, as directed that all Spirits should be deemed and taken to be of the Degree of Strength at which the Hydrometer commonly called *Clarke's* Hydrometer should upon Trial by any Officer or Officers of Excise, denote any such Spirits to be, which was to continue in force until the Fifth Day of *April*, One thousand seven hundred and eighty-eight, and which, by several subsequent Acts was continued until the First Day of *June*, One thousand eight hundred and one, should be made perpetual: and that since the passing of the said Acts, an Hydrometer, called *Sikes's* Hydrometer, had with great care been completed, and had, by proper Experiments, made for that purpose, been ascertained to denote as Proof Spirit that which, at the Temperature of Fifty-one Degrees by *Fahrenheit's* Thermometer, weighs exactly Twelve-thirteenth Parts of an equal Measure of distilled water; and also to determine the Strengths of all other Spirits in proportion to the Quantity of such Proof Spirit which is contained therein, or which can be made from them, with a degree of Accuracy never before attained; and that it was expedient to establish the same in lieu and instead of the said Hydromoter called *Clarke's* Hydrometer, which still remained in use in *Great Britain*, under and by virtue of the said Act; and it was also expedient to repeal the said recited Clause of the said Act made in the Forty-first year of the Reign aforesaid; and also an Act made in the Forty-second year of the Reign aforesaid, intituled, *An Act to authorize the Lord High Treasurer, or Commissioners of the Treasury in* Great Britain, *and the Lord High Treasurer, or the Commissioners of the Treasury in* Ireland, *to order the use of the Hydrometers now employed in the management of the Revenues, to be discontinued, and other Instruments to be used instead thereof;* And whereas the said Act by which the Acts therein recited as aforesaid were repealed, and the Use of *Sikes's* Hydrometer established as aforesaid, will expire on the first day of August, One thousand eight hundred and eighteen; and it is expedient to repeal the said Act, save and except as hereafter mentioned, and make further Provision for the purposes therein mentioned; be it therefore enacted by the King's Most Excellent Majesty, by and with the Advice and Consent of the Lords Spiritual and Temporal, and Commons in this present Parliament assembled, and by the Authority of the same, that from and after the passing of this Act, the said Act of the Fifty-sixth Year aforesaid shall be and the same is hereby repealed, save and except in all cases relating to the recovering any Fine, Penalty, or Forfeiture, Fines, Penalties, or Forfeitures, which shall have been incurred under such Act at any time before or on the passing of this Act, and save and except as to so much of the said Act as repealed the said Clause of the Act of the Forty-first Year, and the said Act of the Forty-second Year of the Reign of his present Majesty, which shall, notwithstanding anything herein contained, remain wholly repealed.

II. It further enacts: That in and throughout the United Kingdom of *Great Britain* and *Ireland*, from and after the passing of this Act, all Spirits shall be deemed and taken to be of the degree of Strength at which the said Hydrometer, called *Sikes's* Hydrometer, used under the directions of the Commissioners of Excise, shall, upon Trial by any Officer or Officers of the Customs or Excise, denote such Spirits to be, except any spirits (not being Foreign Cordials, British Brandy, or British Compounds) which shall be sweetened, or have any ingredient or ingredients mixed with or put into the same, so as to defeat the Operation of the said Hydrometer, or deceive the Officer in trying the true strength thereof with the said Hydrometer, whereby His Majesty may be defrauded; in all and every of which cases, such spirits shall be forfeited, and shall and may be seized by any Officer or Officers of Excise, any thing in any other Act or Acts to the contrary thereof in anywise notwithstanding; and all Rules, Regulations, Provisions, Penalties, Forfeitures, Clauses, Matters, and Things, in any Act or Acts, contained, and not hereby expressly controuled or altered, nor repugnant to the Provisions of this Act, relating to the ascertaining of the Degree of Strength of any Spirits, or to the Degree of Strength of any Spirits for any purpose whatever, relating to the Revenues of Customs and Excise, or either of them, by the said Hydrometer, called *Clarke's* Hydrometer, or by any other Hydrometer, in that Part of the United Kingdom called *Ireland*, shall be in full Force, and applied in all respects as to the said Hydrometer, called *Sikes's* Hydrometer, as fully and effectually as if the same were hereby particularly re-enacted as to such last-mentioned Hydrometer.

III. And whereas the Strengths of Spirits denoted by the said Hydrometer, called *Sikes's* Hydrometer, according to the Temperature thereof, have been, under the Direction of the Commissioners of Excise for *England*, set down in a Table intituled, "A Table of the Strengths of Spirits, denoted by *Sikes's* Hydrometer," and which Table has been and is subscribed by the Hand of the Right Honourable *Nicholas Vansittart*, Chancellor of the Exchequer, and lodged with the Commissioners of Excise for *England*; and it is expedient to make such Provision for and in respect thereof as is hereinafter mentioned; be it therefore enacted, That the Strength of Spirits so set down in the said Table, shall in and throughout the said United Kingdom be deemed and taken to be true and just; and that the said Table shall on all necessary or convenient occasions, be used by every Officer or Officers of His Majesty's Revenues of Customs and Excise respectively, in and throughout the said United Kingdom, for the Purposes in that Behalf aforesaid, and the Result of such Use shall on all Occasions be deemed and taken to be accurate and just Results.

---

*There are five other sections in the Act relating to the alteration of Rates, &c.*

W. Cook & W. F. Jackson, Printers, Woolwich.

Acme
Bookbinding Co., Inc.
100 Cambridge St.
Charlestown, MA 02129

Math
The excise officer's
003344054
Cabot Science
3 2044 091 916 650

108.40
ise officer's manual and imp
cience 003344054
044 091 916 650